Lake Ontario Fish Communities and Fisheries:

2018 Annual Report of the Lake Ontario Management Unit

Ontario

Cover Photos:

(Left) LOMU field crew conducting an assessment of the nearshore fish community in the Toronto Harbour, September 2018. For more information on Lake Ontario nearshore fish community, see Sections 1.3, 7.5, 7.7 and 8.6.

(Top Right) Coho Salmon (top) and Chinook Salmon (bottom) swimming through the Riverwatcher Fish Counter in the Ganaraska Fishway, Ganaraska River, Port Hope, ON, during their fall spawning migration. For more information on Lake Ontario migratory salmon and trout, see Sections 1.4, 1.5, 7.1, 7.2 and 7.3.

(Bottom Right) MNRF's "Rogue" and LOMU field staff at False Duck Island, Eastern Lake Ontario, August 2018, as part of a Walleye acoustic telemetry project in partnership with Queen's University. For more information on Bay of Quinte - Eastern Lake Ontario Walleye, see Sections 2.3, 7.5, 9.16 and 9.17.

LAKE ONTARIO FISH COMMUNITIES AND FISHERIES:

2018 ANNUAL REPORT OF THE LAKE ONTARIO MANAGEMENT UNIT

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Lake Ontario Fish Communities and Fisheries: 2018 Annual Report of the Lake Ontario Management Unit

Foreword

The Lake Ontario Management Unit (LOMU) and the Lake Ontario research staff from the Aquatic Research and Monitoring Section are pleased to provide the 2018 Annual Report of monitoring, assessment, research and management activities.

Lake Ontario fisheries are managed by the Lake Ontario Committee, consisting of the Ontario Ministry of Natural Resources and Forestry (MNRF) in partnership with New York State, under the auspices of the Great Lakes Fishery Commission. The Lake Ontario Fish Community Objectives (2013) provide bi-national fisheries management direction to protect and restore native species and to maintain sustainable fisheries. Our partners include: New York State Department of Environmental Conservation (NYSDEC), Fisheries and Oceans Canada (DFO), the U.S. Fish and Wildlife Service (USFWS), U.S. Geological Survey (USGS) and many other Ontario provincial ministries and conservation authorities and U.S. state and federal agencies, universities and non-government partners.

LOMU continues to deliver a comprehensive long-term base monitoring program while also incorporating new technologies to support fisheries management. In 2018 a new fish counter system was tested on the Credit River. The Walleye telemetry study now has 149 tagged fish from both Ontario and New York State waters and, Lake Whitefish and Cisco were also implanted with acoustic tags to learn more about their movements and habitat use.

In 2018, the Lake Ontario Prey fish Team with the support of the Lake Ontario large vessel fleet including MNRF Ontario Explorer, NYSDEC RV Seth Green and USGS Kaho, conducted 208 trawls starting in April to early May. The results of the prey fish survey show that adult Alewife abundance was low in 2018. Chinook Salmon condition also declined in 2018 and management agencies are concerned about the predator/prey balance in the lake.

We would like to express our sincere appreciation to the many partners and volunteers who contributed to the successful delivery of LOMU initiatives. Special thanks to the Ontario Federation of Anglers and Hunters and the many other partners committed to the Lake Ontario Atlantic Salmon restoration program. LOMU gratefully acknowledges the important contribution of the Lake Ontario Commercial Fishery Liaison Committee, the Fisheries Management Zone 20 Council (FMZ20) members, the Ringwood hatchery partnership with the Metro East Anglers, Chinook Net Pen Committee, Muskies Canada, the Ganaraska River Fishway Volunteers, Napanee and District Rod & Gun Club, and the participants in the angler diary and assessment programs.

Our team of skilled and committed staff and partners delivered an exemplary program that provides long-term benefits to the citizens of Ontario. We are pleased to share the important information about the activities and findings of the Lake Ontario Management Unit from 2018.

Andy Todd
Lake Ontario Manager
613-476-3147

For more detailed information or copies of this report please contact:

Lake Ontario Management Unit
Ontario Ministry of Natural Resources and Forestry
R.R. #4, 41 Hatchery Lane
Picton, ON K0K 2T0 CAN
Telephone: (613) 476-2400
FAX: (613) 476-7131

This Annual Report is available online at: http://www.glfc.org/lakecom/loc/mgmt_unit/index.html

1. Index Fishing Projects

1.1 Lake Ontario and Bay of Quinte Fish Community Index Gill Netting

J. A. Hoyle and E. Brown, Lake Ontario Management Unit

The Lake Ontario and Bay of Quinte annual fish community index gill netting program is used to monitor the abundance and biological characteristics of a diversity of warm, cool and cold-water fish species. Data from the program are used to help manage local commercial and recreational fisheries as well as for tracking long-term changes in the aquatic ecosystem.

Gill net sampling areas are shown in Fig. 1.1.1 and the basic sampling design is summarized in Table 1.1.1. Included in the design are fixed, single-depth sites and depth-stratified sampling areas. In 2018, each site or area was visited from one to three times within specified time-frames, and with one to three gill net gangs set during each visit.

The annual index gill netting field work occurs during the summer months. Summer was chosen based on an understanding of water temperature stability, fish movement/migration patterns, fish growth patterns, and logistical considerations. The time-frames for completion of field work varies among sampling sites/areas (Table 1.1.1). This increases the probability of encountering a wide-range of water temperatures across the depth ranges sampled, both seasonally and by geographic area. In 2018, the Bay of Quinte (Trenton, Belleville, Big Bay, Deseronto, and Hay Bay areas) was also sampled in late October. Seasonal sampling at these Bay of Quinte sites will help better assess seasonal fish distribution and abundance patterns.

Monofilament gill nets with standardized specifications are used (monofilament mesh replaced multifilament in 1992; only catches from 1992-present are tabulated here). Each gill net gang consists of a graded-series of ten

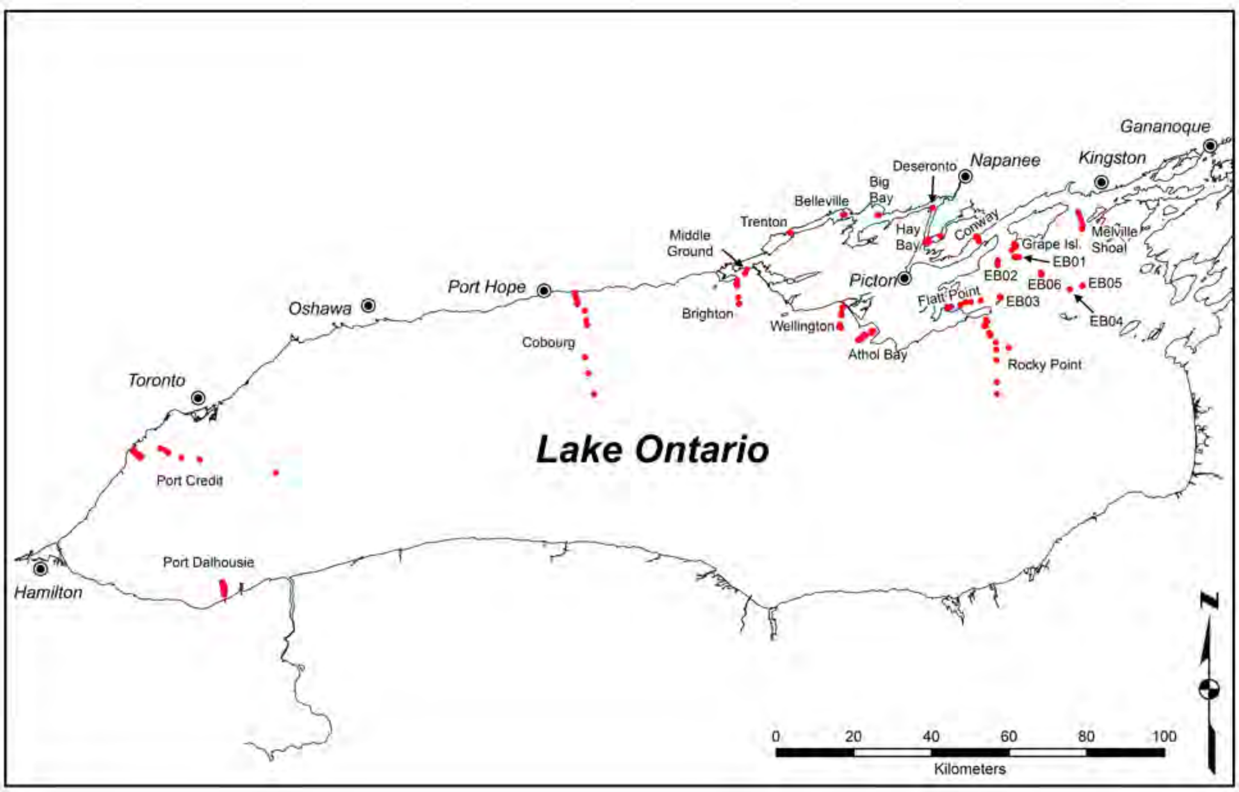


FIG. 1.1.1. Map of Lake Ontario showing fish community index gill netting sites.

TABLE. 1.1.1. Sampling design of the Lake Ontario fish community index gill netting program (Lake Ontario) including geographic and depth stratification, number of visits, number of replicate gill net gangs set during each visit (by gill net length), and the time-frame for completion of visits. Also shown is the year in which gill netting at a particular area/site was initiated and the number of prior years that netting has occurred.

						Replicates by net size[3]		Site location (approx)					
Region name	Area Name (Area code)	Design	Site name	Depth (m)	Visits	465 feet	500 feet	Latitude (dec min)	Longitude (dec min)	Visits x Replicates	Time-frame	Start-up year	Number years[4]
Southwestern Lake Ontario	Port Dalhousie (PD)	Depth stratified area	PD08	7.5	2	2		431294	791615	4	Jul 1-Jul 31	2018	1
Southwestern Lake Ontario	Port Dalhousie	Depth stratified area	PD13	12.5	2	2		431352	791622	4	Jul 1-Jul 31	2018	1
Southwestern Lake Ontario	Port Dalhousie	Depth stratified area	PD18	17.5	2	2		431387	791622	4	Jul 1-Jul 31	2018	1
Southwestern Lake Ontario	Port Dalhousie	Depth stratified area	PD23	22.5	2	2		431426	791647	4	Jul 1-Jul 31	2018	1
Southwestern Lake Ontario	Port Dalhousie	Depth stratified area	PD28	27.5	2	2		431458	791667	4	Jul 1-Jul 31	2018	1
Northwestern Lake Ontario	Port Credit (PC)	Depth stratified area	PC08	7.5	2	2		433230	793476	4	Jul 1-Jul 31	2014	5
Northwestern Lake Ontario	Port Credit	Depth stratified area	PC13	12.5	2	2		433182	793403	4	Jul 1-Jul 31	2014	5
Northwestern Lake Ontario	Port Credit	Depth stratified area	PC18	17.5	2	2		433164	793355	4	Jul 1-Jul 31	2014	5
Northwestern Lake Ontario	Port Credit	Depth stratified area	PC23	22.5	2	2		433156	793335	4	Jul 1-Jul 31	2014	5
Northwestern Lake Ontario	Port Credit	Depth stratified area	PC28	27.5	2	2		433143	793308	4	Jul 1-Jul 31	2014	5
Northwestern Lake Ontario	Port Credit	Depth stratified area	PC40	40	1		3	433269	792976	3	Jul 1-Jul 31	2016	3
Northwestern Lake Ontario	Port Credit	Depth stratified area	PC50	50	1		3	433249	792874	3	Jul 1-Jul 31	2016	3
Northwestern Lake Ontario	Port Credit	Depth stratified area	0060	60	1		3	433213	792808	3	Jul 1-Jul 31	2014	5
Northwestern Lake Ontario	Port Credit	Depth stratified area	0080	80	1		3	433190	792515	3	Jul 1-Jul 31	2014	5
Northwestern Lake Ontario	Port Credit	Depth stratified area	0100	100	1		3	433162	792161	3	Jul 1-Jul 31	2014	5
Northwestern Lake Ontario	Port Credit	Depth stratified area	0140	140	1		3	433065	790735	3	Jul 1-Jul 31	2014	5
North Central Lake Ontario	Cobourg (CB)	Depth stratified area	CB08	7.5	2	2		435701	781167	4	Jul 1-Sep 15	2010	9
North Central Lake Ontario	Cobourg	Depth stratified area	CB13	12.5	2	2		435661	781157	4	Jul 1-Sep 15	2010	9
North Central Lake Ontario	Cobourg	Depth stratified area	CB18	17.5	2	2		435622	781136	4	Jul 1-Sep 15	2010	9
North Central Lake Ontario	Cobourg	Depth stratified area	CB23	22.5	2	2		435584	781109	4	Jul 1-Sep 15	2010	9
North Central Lake Ontario	Cobourg	Depth stratified area	CB28	27.5	2	2		435549	781110	4	Jul 1-Sep 15	2010	9
North Central Lake Ontario	Cobourg	Depth stratified area	CB40	40	1		3	435454	780943	3	Jul 1-Jul 31	2016	3
North Central Lake Ontario	Cobourg	Depth stratified area	CB50	50	1		3	435299	780924	3	Jul 1-Jul 31	2016	3
North Central Lake Ontario	Cobourg	Depth stratified area	0060	60	1		3	435257	780916	3	Jul 1-Jul 31	2014	5
North Central Lake Ontario	Cobourg	Depth stratified area	0080	80	1		3	434813	780919	3	Jul 1-Jul 31	2014	3
North Central Lake Ontario	Cobourg	Depth stratified area	0100	100	1		3	434589	780857	3	Jul 1-Jul 31	2014	3
North Central Lake Ontario	Cobourg	Depth stratified area	0140	140	1		3	434310	780728	3	Jul 1-Jul 31	2014	3
Northeastern Lake Ontario	Brighton (BR)	Depth stratified area	BR08	7.5	2	2		435955	774058	4	Aug 1-Sep 15	1988	31
Northeastern Lake Ontario	Brighton	Depth stratified area	BR13	12.5	2	2		435911	774071	4	Aug 1-Sep 15	1988	31
Northeastern Lake Ontario	Brighton	Depth stratified area	BR18	17.5	2	2		435878	774053	4	Aug 1-Sep 15	1988	31
Northeastern Lake Ontario	Brighton	Depth stratified area	BR23	22.5	2	2		435777	774034	4	Aug 1-Sep 15	1988	31
Northeastern Lake Ontario	Brighton	Depth stratified area	BR28	27.5	2	2		435624	774004	4	Aug 1-Sep 15	1988	31
Northeastern Lake Ontario	Middle Ground (MG)	Fixed site	MG05	5	2	2		440054	773906	4	Aug 1-Sep 15	1979	40
Northeastern Lake Ontario	Wellington (WE)	Depth stratified area	WE08	7.5	2	2		435622	772011	4	Aug 1-Sep 15	1988	31
Northeastern Lake Ontario	Wellington	Depth stratified area	WE13	12.5	2	2		435544	772027	4	Aug 1-Sep 15	1988	31
Northeastern Lake Ontario	Wellington	Depth stratified area	WE18	17.5	2	2		435515	772025	4	Aug 1-Sep 15	1988	31
Northeastern Lake Ontario	Wellington	Depth stratified area	WE23	22.5	2	2		435378	772050	4	Aug 1-Sep 15	1988	31
Northeastern Lake Ontario	Wellington	Depth stratified area	WE28	27.5	2	2		435348	772066	4	Aug 1-Sep 15	1988	31
Northeastern Lake Ontario	Athol Bay (AB)	Depth stratified area	AB08	7.5	2	2		435297	771396	4	Aug 1-Sep 15	2018	1
Northeastern Lake Ontario	Athol Bay	Depth stratified area	AB13	12.5	2	2		435282	771444	4	Aug 1-Sep 15	2018	1
Northeastern Lake Ontario	Athol Bay	Depth stratified area	AB18	17.5	2	2		435244	771554	4	Aug 1-Sep 15	2018	1
Northeastern Lake Ontario	Athol Bay	Depth stratified area	AB23	22.5	2	2		435199	771619	4	Aug 1-Sep 15	2018	1
Northeastern Lake Ontario	Athol Bay	Depth stratified area	AB28	27.5	2	2		435174	771690	4	Aug 1-Sep 15	2018	1
Northeastern Lake Ontario	Rocky Point (RP)	Depth stratified area	RP08	7.5	2	2		435510	765220	4	Jul 21-Sep 15	1988	31
Northeastern Lake Ontario	Rocky Point	Depth stratified area	RP13	12.5	2	2		435460	765230	4	Jul 21-Sep 15	1988	31
Northeastern Lake Ontario	Rocky Point	Depth stratified area	RP18	17.5	2	2		435415	765222	4	Jul 21-Sep 15	1988	31
Northeastern Lake Ontario	Rocky Point	Depth stratified area	RP23	22.5	2	2		435328	765150	4	Jul 21-Sep 15	1988	31
Northeastern Lake Ontario	Rocky Point	Depth stratified area	RP28	27.5	2	2		435285	765135	4	Jul 21-Sep 15	1988	31
Northeastern Lake Ontario	Rocky Point	Depth stratified area	0040	40	1		3	435190	765040	3	Jul 1-Jul 31	2016	3
Northeastern Lake Ontario	Rocky Point	Depth stratified area	0050	50	1		3	435090	765030	3	Jul 1-Jul 31	2016	3
Northeastern Lake Ontario	Rocky Point	Depth stratified area	0060	60	1		3	434950	765029	3	Jul 1-Jul 31	1997	22
Northeastern Lake Ontario	Rocky Point	Depth stratified area	0080	80	1		3	434633	765006	3	Jul 1-Jul 31	1997	22
Northeastern Lake Ontario	Rocky Point	Depth stratified area	0100	100	1		3	434477	764998	3	Jul 1-Jul 31	1997	22
Northeastern Lake Ontario	Rocky Point	Depth stratified area	0140	140	1		3	434122	764808	3	Jul 1-Jul 31	1997	22
Kingston Basin (nearshore)	Flatt Point (FP)	Depth stratified area	FP08	7.5	2	2		435665	765993	4	Jul 1-Jul 31	1986	33
Kingston Basin (nearshore)	Flatt Point	Depth stratified area	FP13	12.5	2	2		435659	765927	4	Jul 1-Jul 31	1986	33
Kingston Basin (nearshore)	Flatt Point	Depth stratified area	FP18	17.5	2	2		435688	765751	4	Jul 1-Jul 31	1986	33
Kingston Basin (nearshore)	Flatt Point	Depth stratified area	FP23	22.5	2	2		435726	765541	4	Jul 1-Jul 31	1986	33
Kingston Basin (nearshore)	Flatt Point	Depth stratified area	FP28	27.5	2	2		435754	765314	4	Jul 1-Jul 31	1986	33
Kingston Basin (nearshore)	Grape Island (GI)	Depth stratified area	GI08	7.5	2	2		440537	764712	4	Jul 1-Jul 31	1986	33
Kingston Basin (nearshore)	Grape Island	Depth stratified area	GI13	12.5	2	2		440523	764747	4	Jul 1-Jul 31	1986	33
Kingston Basin (nearshore)	Grape Island	Depth stratified area	GI18	17.5	2	2		440476	764710	4	Jul 1-Jul 31	1986	33
Kingston Basin (nearshore)	Grape Island	Depth stratified area	GI23	22.5	2	2		440405	764718	4	Jul 1-Jul 31	1986	33
Kingston Basin (nearshore)	Grape Island	Depth stratified area	GI28	27.5	2	2		440470	764796	4	Jul 1-Jul 31	1986	33
Kingston Basin (nearshore)	Melville Shoal (MS)	Depth stratified area	MS08	7.5	2	2		441030	763500	4	Jul 1-Jul 31	1986	33
Kingston Basin (nearshore)	Melville Shoal	Depth stratified area	MS13	12.5	2	2		441004	763470	4	Jul 1-Jul 31	1986	33
Kingston Basin (nearshore)	Melville Shoal	Depth stratified area	MS18	17.5	2	2		440940	763460	4	Jul 1-Jul 31	1986	33
Kingston Basin (nearshore)	Melville Shoal	Depth stratified area	MS23	22.5	2	2		440835	763424	4	Jul 1-Jul 31	1986	33
Kingston Basin (nearshore)	Melville Shoal	Depth stratified area	MS28	27.5	2	2		440792	763424	4	Jul 1-Jul 31	1986	33

TABLE 1.1.1. (continued). Sampling design of the Lake Ontario fish community index gill netting program (Bay of Quinte) including geographic and depth stratification, number of visits, number of replicate gill net gangs set during each visit (by gill net length), and the time-frame for completion of visits. Also shown is the year in which gill netting at a particular area/site was initiated and the number of prior years that netting has occurred.

						Replicates by net size[3]		Site location (approx)					
Region name	Area Name (Area code)	Design	Site name	Depth (m)	Visits	465 feet	500 feet	Latitude (dec min)	Longitude (dec min)	Visits x Replicates	Time-frame	Start-up year	Number years[4]
Kinston Basin (offshore)	Eastern Basin (EB)	Fixed site	EB01	31	3	3		440400	764650	9	Jun 18-Jul 15; Jul 16-Aug 12; Aug 13 Sep 15	2016	3
Kinston Basin (offshore)	Eastern Basin (EB)	Fixed site	EB02	30	3	3		440330	765050	9	Jun 18-Jul 15; Jul 16-Aug 12; Aug 13 Sep 15	1968	51
Kinston Basin (offshore)	Eastern Basin (EB)	Fixed site	EB03	25	3	3		435820	764950	9	Jun 18-Jul 15; Jul 16-Aug 12; Aug 13 Sep 15	2016	3
Kinston Basin (offshore)	Eastern Basin (EB)	Fixed site	EB04	27	3	3		435940	763610	9	Jun 18-Jul 15; Jul 16-Aug 12; Aug 13 Sep 15	2016	3
Kinston Basin (offshore)	Eastern Basin (EB)	Fixed site	EB05	29	3	3		440000	763400	9	Jun 18-Jul 15; Jul 16-Aug 12; Aug 13 Sep 15	2016	3
Kinston Basin (offshore)	Eastern Basin (EB)	Fixed site	EB06	30	3	3		440220	764210	9	Jun 18-Jul 15; Jul 16-Aug 12; Aug 13 Sep 15	1968	51
Bay of Quinte	Conway	Depth stratified area	CO08	7.5	2	2		440664	765463	4	Jul 21-Aug 21	1972	47
Bay of Quinte	Conway	Depth stratified area	CO13	12.5	2	2		440649	765452	4	Jul 21-Aug 21	1972	47
Bay of Quinte	Conway	Depth stratified area	CO20	20	2	2		440643	765453	4	Jul 21-Aug 21	1972	47
Bay of Quinte	Conway	Depth stratified area	CO30	30	2	2		440620	765440	4	Jul 21-Aug 21	1972	47
Bay of Quinte	Conway	Depth stratified area	CO45	45	2	2		440601	765402	4	Jul 21-Aug 21	1972	47
Bay of Quinte	Hay Bay (HB)[2]	Depth stratified area	HB08	7.5	4	2		440656	770156	8	Jun 15-Jul 15 (1 visit); Jul 21-Aug 21 (2 visits); Oct 15-Nov 15 (1 visit)	1959	60
Bay of Quinte	Hay Bay	Depth stratified area	HB13	12.5	4	2		440575	770400	8	Jun 15-Jul 15 (1 visit); Jul 21-Aug 21 (2 visits); Oct 15-Nov 15 (1 visit)	1959	60
Bay of Quinte	Deseronto (DE)	Fixed site	DE05	5	3	2		441035	770339	6	Jun 15-Jul 15 (1 visit); Jul 21-Aug 21 (1 visit); Oct 15-Nov 15 (1 visit)	2016	3
Bay of Quinte	Big Bay (BB)	Fixed site	BB05	5	4	2		440920	771360	8	Jun 15-Jul 15 (1 visit); Jul 21-Aug 21 (2 visits); Oct 15-Nov 15 (1 visit)	1972	47
Bay of Quinte	Belleville (BE)	Fixed site	BE05	5	3	2		440914	772048	6	Jun 15-Jul 15 (1 visit); Jul 21-Aug 21 (1 visit); Oct 15-Nov 15 (1 visit)	2016	3
Bay of Quinte	Trenton (TR)	Fixed site	TR05	5	3	2		440636	773063	6	Jun 15-Jul 15 (1 visit); Jul 21-Aug 21 (1 visit); Oct 15-Nov 15 (1 visit)	2016	3

[1] changed from a fixed site where the gillnet was set perpendicular to shore across contours to a depth stratified site with five depths in 1992

[2] changed from a fixed site where the gillnet was set parallel and close to shore to a depth stratified area with two depths (sites) in 1992

[3] two types of gillnet effort are used; both types consist of a graded series of mesh sizes attached in order by size from 38-153 mm at 13 mm intervals; one type has 15 ft of 38 mm mesh and 50 ft of all nine other mesh sizes the second type has 50 ft of all mesh sizes

[4] the basic sampling design of the program has been largely consistent since 1992; for years prior to 1992 consult field protocols and FISHNET project definitions for changes in sampling design.

monofilament gill net panels of mesh sizes from 38 mm (1½ in) to 152 mm (6 in) stretched mesh at 13 mm (½ in) intervals, arranged in sequence. However, a standard gill net gang may consist of one of two possible configurations. Either, all ten mesh sizes (panels) are 15.2 m (50 ft) in length (total gang length is 152.4 m (500 ft)), or, the 38 mm (1½ in) mesh size (panel) is 4.6 m (15 ft) in length and the remaining mesh sizes are 15.2 m (50 ft) each in length (total gang length is 141.7 m (465 ft)) (see Table 1.1.1). Note that use of the shorter 38 mm gill net panel is related to the processing time required to deal with large numbers of small fish (e.g., Alewife and Yellow Perch) caught in this small mesh size. Gill net gangs are connected in series (i.e., cork lines and lead lines attached), but are separated by a 15.2 m (50 ft) spacer to minimize "leading" of fish. The 152 mm (6 in) end of one gang is connected to the 38 mm (1 ½ in) gang of the adjoining gang. The entire gill net strap (all joined gangs) is set within 2.5 m of the site depth listed in Table 1.1.1. The gill net set duration target ranges from 18-24 hours. Gill net catches were summed across the ten mesh sizes from 1½-6 inch. In the case where the 38 mm mesh size used was 4.6 m in length, the catch in this mesh was adjusted (i.e., multiplied by 15.2/4.6) prior to summing the ten mesh sizes. Therefore, all reported catches represent the total catch in a 152.4 m (500 ft) gang of gill net.

In 2018, 374 gill net samples were made from Jun 18 to Oct 30. Thirty-eight different species and 20,273 individual fish were caught. About 72% of the observed catch was alewife (Table 1.1.2). Species-specific gill net catch summaries are shown by geographic area/site in Tables 1.1.3-1.1.24.

Selected biological information is also presented below for Lake Whitefish, Cisco and Walleye.

TABLE 1.1.2. Species-specific catch per gill net set in 2018 from June 18 to October 30. "Standard catch" is the observed catch expanded to represent the catch in a 50 ft panel length of 1 1/2 inch mesh size in cases where only 15 ft was used. A total of 374 gill nets were set and 38 species comprising 20,273 fish were caught.

Species	Observed catch	Standard catch	Mean weight (g)
Sea Lamprey	1	1	310
Lake Sturgeon	2	2	n/a
Longnose Gar	41	53	1,860
Bowfin	1	3	2,299
Alewife	14,568	43,252	34
Gizzard Shad	82	84	755
Coho Salmon	2	2	1,419
Chinook Salmon	46	51	1,523
Rainbow Trout	3	3	1,368
Atlantic Salmon	2	2	1,423
Brown Trout	90	92	2,302
Lake Trout	417	429	3,167
Lake Whitefish	32	32	1,004
Cisco	117	122	471
Rainbow Smelt	17	29	35
Northern Pike	33	35	2,244
White Sucker	205	205	672
Silver Redhorse	3	3	1,087
Shorthead Redhorse	1	1	1,147
River Redhorse	1	1	562
Common Carp	2	2	5,721
Golden Shiner	1	1	41
Brown Bullhead	25	25	311
Channel Catfish	3	3	3,355
American Eel	1	3	1,451
Burbot	5	5	3,333
Trout-perch	1	3	
White Perch	1,379	1,840	99
White Bass	42	47	243
Rock Bass	57	98	178
Pumpkinseed	52	68	56
Bluegill	23	55	41
Smallmouth Bass	70	76	1,231
Yellow Perch	1,569	3,770	73
Walleye	962	979	1,604
Round Goby	195	640	39
Freshwater Drum	204	209	625
Deepwater Sculpin	17	17	33
Lake Whitefish x Cisco	1	1	973

Lake Ontario

Northeast (Brighton, Wellington and Rocky Point) and Kingston Basin (Melville Shoal, Grape Island and Flatt Point) Nearshore Areas (Tables 1.1.3-1.1.8 inclusive)

Six depth-stratified sampling areas (Melville Shoal, Grape Island, Flat Point, Rocky Point, Wellington and Brighton) that employ a common and balanced sampling design were used here to provide a broad picture of the warm, cool and cold-water fish community inhabiting the open-coastal waters out to about 30 m water depth in the eastern half of Lake Ontario. Results were summarized and presented graphically (Fig. 1.1.2) to illustrate abundance trends of the most abundant fish species.

Many species showed peak abundance levels in the early 1990s followed by dramatic abundance decline. Alewife, the most common species caught, has occurred at very high abundance levels after 2008 until 2014 when abundance declined precipitously. Alewife abundance increased in 2015 and again in 2016, remained stable in 2017, and declined in 2018. Yellow Perch abundance declined in 2018 to its lowest point in the time-series. Round Goby abundance declined after 2007 to low points in 2014 and 2015, increased in 2016, and remained stable in 2017 and 2018. Lake Trout abundance remained low in 2018. Walleye catch declined slightly in 2018 but remains high. Lake Whitefish remain at a very low abundance level. Rock Bass abundance declined and Smallmouth Bass abundance increased in 2018. Chinook Salmon and Brown Trout abundance increased in 2018.

Middle Ground (Table 1.1.9)

Middle Ground represents one of our longest running gill netting locations. Nine species were caught at Middle Ground in 2018. Yellow Perch dominated the catch.

Kingston Basin—Deep Sites (EB02 and EB06; Tables 1.1.10 and 1.1.11)

Two single-depth sites (EB02 and EB06) are used to monitor long-term trends in the deep-water fish community the Kingston Basin. Results were summarized and presented graphically (Fig. 1.1.3) to illustrate abundance trends of the most abundant species (Alewife,

TABLE 1.1.3. Species-specific catch per gillnet set at **Brighton in Northeastern Lake Ontario**, 1992-2018. Annual catches are averages for 1-3 gillnet gangs set at each of 5 depths (7.5, 12.5, 17.5, 22.5 and 27.5 m) during each of 1-3 visits during summer. Mean catches for 1992-2000 and 2001-2010 time-periods are shown in **bold**. The total number of species caught and gillnets set each year are indicated.

	1992-2000 mean	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	**2001-2010 mean**	2011	2012	2013	2014	2015	2016	2017	2018
Bowfin	**-**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	0.05	-	-
Alewife	**34.82**	49.58	107.40	31.81	22.39	41.27	72.52	3.52	89.17	209.81	67.05	**69.45**	307.74	138.36	295.25	70.48	343.08	191.56	174.10	87.35
Gizzard Shad	**0.44**	-	-	-	-	-	-	-	-	-	0.15	**0.02**	-	-	0.05	-	-	0.20	0.05	1.45
Coho Salmon	**0.004**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Chinook Salmon	**0.74**	0.10	0.35	1.25	0.45	0.42	0.20	0.62	0.30	0.05	0.71	**0.44**	0.83	0.10	-	0.20	-	0.20	0.22	0.05
Rainbow Trout	**-**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	0.10	-	-	-	-	-
Atlantic Salmon	**-**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	0.05
Brown Trout	**0.12**	-	-	0.35	0.20	0.05	0.15	0.10	0.30	0.15	1.25	**0.26**	0.60	0.50	0.15	0.10	0.20	0.20	-	0.30
Lake Trout	**5.22**	1.30	1.05	0.40	0.95	0.15	0.30	0.05	-	0.05	0.10	**0.44**	0.15	0.20	0.10	0.85	0.57	1.09	0.83	0.65
Lake Whitefish	**0.42**	0.05	-	0.05	-	-	-	-	-	-	-	**0.01**	-	-	-	-	-	-	0.05	-
Cisco	**0.12**	-	-	0.05	-	0.10	0.10	0.05	0.25	0.05	-	**0.06**	0.05	-	0.05	0.05	0.10	0.55	0.32	0.40
Round Whitefish	**1.19**	-	0.25	0.05	0.05	-	-	-	-	-	-	**0.04**	-	-	-	-	-	-	-	-
Rainbow Smelt	**0.11**	-	-	-	-	-	-	-	-	-	0.10	**0.01**	0.22	-	0.05	-	-	-	0.17	0.10
Northern Pike	**0.08**	-	-	0.05	-	0.10	-	0.20	0.05	0.05	-	**0.05**	0.05	-	-	0.15	0.30	-	-	0.05
White Sucker	**0.41**	-	0.10	-	0.05	0.15	0.05	0.10	-	-	0.05	**0.05**	0.05	-	-	0.15	-	0.35	-	-
Lake Chub	**-**	-	-	-	-	-	-	-	0.17	-	-	**0.02**	-	-	-	-	-	-	-	-
Common Carp	**0.12**	-	-	0.05	-	-	-	-	-	-	-	**0.01**	-	-	-	-	-	0.05	-	-
Brown Bullhead	**0.10**	0.52	0.20	0.85	0.27	0.35	-	0.25	0.22	0.05	-	**0.27**	-	-	-	0.17	-	-	-	-
Channel Catfish	**0.01**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
American Eel	**0.004**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Burbot	**0.05**	0.05	-	-	-	-	0.05	0.05	-	-	-	**0.02**	-	-	-	0.05	0.05	0.05	0.15	-
White Perch	**0.03**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Rock Bass	**0.88**	-	0.32	0.63	0.76	0.32	0.15	0.32	0.80	0.33	0.33	**0.39**	-	1.65	-	0.22	0.05	0.47	1.52	0.37
Pumpkinseed	**0.01**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Smallmouth Bass	**0.00**	-	-	-	-	-	-	-	-	-	0.05	**0.01**	-	-	-	-	-	-	-	-
Yellow Perch	**15.64**	-	0.50	0.50	0.33	1.16	2.99	1.57	4.83	0.17	0.17	**1.22**	-	1.98	2.36	0.17	-	1.54	-	-
Walleye	**0.44**	-	0.15	0.25	0.50	0.20	0.05	0.75	0.10	-	0.10	**0.21**	-	0.43	0.05	0.15	0.10	0.45	0.20	0.20
Round Goby	**-**	-	-	0.17	0.17	4.45	1.98	0.63	1.70	1.32	0.99	**1.14**	1.21	2.31	0.99	0.17	1.82	3.30	2.64	2.64
Freshwater Drum	**0.17**	-	-	0.15	0.10	-	0.05	0.05	-	-	-	**0.04**	-	-	-	-	-	-	-	0.05
Total catch	**61**	52	110	37	26	49	79	8	98	212	71	**74**	311	146	299	73	346	200	180	94
Number of species	**13**	6	9	15	12	12	12	14	11	10	12	**11**	9	8	10	13	9	14	11	13
Number of sets		20	20	20	20	20	20	20	20	20	20		20	10	20	20	20	20	20	20

TABLE 1.1.4. Species-specific catch per gillnet set at **Wellington in Northeastern Lake Ontario**, 1992-2018. Annual catches are averages for 1-3 gillnet gangs set at each of 5 depths (7.5, 12.5, 17.5, 22.5 and 27.5 m) during each of 1-3 visits during summer. Mean catches for 1992-2000 and 2001-2010 time-periods are shown in **bold**. The total number of species caught and gillnets set each year are indicated.

	1992-2000 mean	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	**2001-2010 mean**	2011	2012	2013	2014	2015	2016	2017	2018
Alewife	**17.25**	20.85	50.58	62.26	38.23	83.22	137.33	1.54	79.05	447.66	215.85	**113.66**	475.42	140.74	460.72	99.79	245.34	104.95	143.58	44.79
Gizzard Shad	**0.02**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Chinook Salmon	**0.33**	0.10	0.20	0.35	1.20	0.10	0.20	0.35	0.45	-	0.10	**0.31**	0.65	-	0.15	0.15	0.15	0.25	0.10	0.52
Rainbow Trout	**-**	-	-	-	-	-	-	-	-	-	0.05	**0.01**	-	-	-	-	-	-	-	-
Brown Trout	**0.11**	0.15	0.30	0.15	0.40	0.15	-	0.10	0.40	0.45	1.55	**0.37**	0.60	0.80	0.40	0.05	0.15	0.30	-	0.70
Lake Trout	**7.58**	2.40	2.20	0.85	1.85	0.45	0.70	0.40	0.05	0.25	0.10	**0.93**	0.25	0.40	0.05	0.20	-	0.05	1.10	1.75
Lake Whitefish	**0.61**	0.10	0.05	-	-	-	-	-	-	-	-	**0.02**	0.35	-	-	0.20	-	0.05	-	-
Cisco	**0.11**	-	-	-	-	-	0.05	-	-	0.05	0.05	**0.02**	0.05	-	-	-	-	0.20	0.35	0.05
Round Whitefish	**0.06**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Rainbow Smelt	**0.07**	-	-	-	-	-	-	-	0.05	0.10	0.17	**0.03**	0.05	0.10	-	0.05	-	0.17	0.47	0.05
Northern Pike	**0.01**	-	-	0.05	-	-	-	-	-	-	-	**0.01**	0.05	-	0.05	-	-	-	-	-
White Sucker	**0.05**	-	-	-	0.17	-	-	0.05	-	-	-	**0.02**	-	-	-	-	-	-	-	-
Greater Redhorse	**-**	-	-	0.05	-	-	-	-	-	-	-	**0.01**	-	-	-	-	-	-	-	-
Lake Chub	**0.03**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Common Carp	**0.02**	-	-	-	-	0.05	-	-	-	-	-	**0.01**	-	-	-	-	-	-	-	0.05
Brown Bullhead	**0.00**	0.05	0.10	-	0.05	0.15	-	-	-	-	-	**0.04**	-	-	-	-	-	-	-	-
Burbot	**0.23**	0.10	0.25	0.05	0.05	-	0.10	-	0.05	-	0.05	**0.07**	-	0.10	-	0.05	-	0.15	0.05	0.05
White Perch	**0.00**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Rock Bass	**0.35**	0.17	-	0.52	0.10	0.05	-	-	0.58	-	-	**0.14**	-	-	0.05	-	-	0.10	0.10	0.05
Smallmouth Bass	**0.03**	-	-	-	-	-	-	-	-	-	-	**-**	0.05	-	-	-	-	-	-	-
Yellow Perch	**31.00**	12.67	6.22	17.96	10.31	14.51	7.25	23.48	17.65	25.87	14.11	**15.00**	2.47	19.87	11.71	16.80	7.50	26.95	28.91	5.98
Walleye	**0.36**	-	0.10	0.20	0.25	0.20	0.10	0.10	-	-	0.05	**0.10**	0.05	-	0.10	0.05	-	0.05	0.10	0.25
Round Goby	**-**	-	-	0.33	0.99	25.92	18.39	2.03	11.50	1.16	6.94	**6.73**	3.35	2.97	3.30	0.33	2.53	2.64	1.65	1.82
Freshwater Drum	**0.25**	-	0.05	-	0.05	0.05	-	-	-	-	-	**0.02**	-	0.10	-	-	-	-	-	-
Total catch	**58**	37	60	83	54	125	164	28	110	476	239	**137**	483	165	477	118	256	136	176	56
Number of species	**11**	9	10	11	12	11	8	8	9	7	11	**10**	12	8	9	10	5	12	10	12
Number of sets		20	20	20	20	20	20	20	20	20	20		20	10	20	20	20	20	20	20

TABLE 1.1.5. Species-specific catch per gillnet set at **Rocky Point (nearshore sites only) in Northeastern Lake Ontario**, 1992-2018. Annual catches are averages for 1-3 gillnet gangs set at each of 5 depths (7.5, 12.5, 17.5, 22.5 and 27.5 m) during each of 2-3 visits during summer. Mean catches for 1992-2000 and 2001-2010 time-periods are shown in **bold**. The total number of species caught and gillnets set each year are indicated.

	1992-2000 mean	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	**2001-2010 mean**	2011	2012	2013	2014	2015	2016	2017	2018
Alewife	**131.93**	105.42	141.61	86.90	155.51	293.30	142.82	135.36	231.74	176.68	662.38	**213.17**	530.40	127.84	512.07	192.74	135.43	225.92	69.31	166.90
Chinook Salmon	**0.23**	-	0.10	0.25	0.55	0.15	0.27	0.10	0.15	-	0.70	**0.23**	0.20	-	0.25	0.15	0.05	0.43	0.15	0.45
Rainbow Trout	**-**	-	-	-	-	-	0.05	-	-	-	-	**0.01**	-	-	0.05	-	-	-	-	-
Atlantic Salmon	**0.02**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Brown Trout	**0.09**	-	1.20	0.05	0.25	0.25	0.45	0.10	0.50	-	0.80	**0.36**	1.55	1.10	0.95	0.05	0.15	0.15	-	0.85
Lake Trout	**5.40**	1.67	0.80	0.10	0.60	-	0.47	0.05	0.25	0.05	0.32	**0.43**	1.35	4.10	0.75	1.90	1.10	0.40	0.20	1.03
Lake Whitefish	**0.69**	0.05	-	0.30	0.10	0.05	0.10	0.05	0.25	0.45	-	**0.14**	0.10	0.30	0.10	0.10	-	-	-	-
Cisco	**0.07**	-	-	-	-	-	-	-	-	-	-	**-**	0.05	-	-	-	-	0.05	0.20	0.05
Chub	**-**	0.17	-	-	-	-	-	-	-	-	-	**0.02**	-	-	-	-	-	-	-	-
Rainbow Smelt	**0.03**	-	-	-	-	-	-	-	0.17	-	-	**0.02**	-	-	-	-	-	-	-	-
Northern Pike	**-**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	0.05
White Sucker	**0.04**	0.05	-	-	-	-	-	0.05	-	-	-	**0.01**	-	-	-	-	-	-	0.05	0.05
Lake Chub	**0.11**	-	0.17	-	-	-	-	0.05	-	-	-	**0.02**	-	-	-	-	-	-	-	-
Common Carp	**0.01**	-	-	-	0.10	0.05	-	-	-	-	-	**0.02**	-	-	-	-	-	-	0.05	-
Brown Bullhead	**-**	-	-	-	0.05	-	-	-	-	-	-	**0.01**	-	-	-	-	-	-	-	-
Channel Catfish	**-**	-	-	-	-	-	-	-	-	0.05	-	**0.01**	-	-	-	-	-	-	-	-
Stonecat	**0.01**	0.70	0.17	0.05	-	0.10	0.05	0.27	-	-	-	**0.13**	-	-	-	-	-	-	-	-
Burbot	**0.28**	0.15	0.35	0.10	0.05	0.30	-	-	-	-	0.05	**0.10**	-	-	-	0.05	-	0.05	-	-
White Perch	**-**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	0.05					
Rock Bass	**0.31**	0.32	0.53	0.87	0.05	0.35	0.55	0.63	0.86	0.32	0.86	**0.53**	0.05	0.73	0.48	0.27	0.98	0.17	0.65	0.43
Smallmouth Bass	**1.05**	0.70	0.65	0.67	0.80	0.42	0.42	0.52	0.55	0.15	0.50	**0.54**	0.20	0.53	0.37	0.10	0.10	0.77	1.07	1.33
Yellow Perch	**0.06**	-	-	-	-	0.17	0.81	0.88	0.22	0.33	1.75	**0.42**	0.60	0.66	-	-	-	0.17	0.17	-
Walleye	**0.67**	-	0.25	0.10	0.80	1.60	0.65	0.85	0.65	0.15	0.45	**0.55**	0.10	0.20	0.70	1.10	1.15	0.20	1.75	1.88
Round Goby	**-**	-	-	-	-	2.15	8.48	71.25	9.50	28.26	15.93	**13.56**	6.54	7.60	13.88	4.51	0.83	7.07	8.26	9.14
Freshwater Drum	**0.19**	0.10	0.05	0.05	0.30	-	0.10	-	0.20	0.15	0.15	**0.11**	-	-	-	-	-	-	-	0.10
Total catch	**141**	109	146	89	159	299	155	210	245	207	684	**230**	541	143	530	201	140	235	82	182
Number of species	**10**	10	11	11	12	12	13	13	12	10	11	**12**	11	9	11	10	8	11	11	12
Number of sets		20	20	20	20	20	20	20	20	20	20		20	10	20	20	20	20	20	20

TABLE 1.1.6. Species-specific catch per gillnet set at **Flatt Point in the Kingston Basin of Lake Ontario**, 1992-2018. Annual catches are averages for 1-3 gillnet gangs set at each of 5 depths (7.5, 12.5, 17.5, 22.5 and 27.5 m) during each of 2-3 visits during summer. Mean catches for 1992-2000 and 2001-2010 time-periods are shown in **bold**. The total number of species caught and gillnets set each year are indicated.

	1992-2000 mean	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	**2001-2010 mean**	2011	2012	2013	2014	2015	2016	2017	2018
Sea Lamprey	**-**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	0.05
Lake Sturgeon	**0.01**	-	-	0.05	-	-	-	-	-	-	-	**0.01**	-	-	-	-	-	-	-	-
Alewife	**78.18**	45.97	5.17	6.87	101.38	141.78	203.18	140.02	297.45	305.56	620.72	**186.81**	908.17	818.60	337.43	11.57	293.48	487.80	885.96	133.43
Gizzard Shad	**-**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	0.15
Chinook Salmon	**0.16**	-	-	-	0.35	0.05	-	0.10	-	-	0.05	**0.06**	0.05	0.15	-	-	-	-	-	0.05
Rainbow trout	**-**	-	-	-	-	-	-	-	-	-	-	**-**	-	0.15						
Brown Trout	**0.02**	0.10	-	-	-	-	0.10	-	0.10	0.05	0.10	**0.05**	0.55	0.55	0.20	0.05	-	-	0.05	0.10
Lake Trout	**10.72**	2.47	0.75	1.25	0.98	0.88	0.30	1.22	0.92	2.07	1.00	**1.18**	1.95	0.60	2.20	2.45	0.70	0.72	0.25	0.50
Lake Whitefish	**4.17**	4.60	2.72	0.85	2.80	0.55	0.20	1.30	0.75	0.15	0.25	**1.42**	0.25	0.95	0.20	0.05	0.42	0.35	0.05	0.05
Cisco	**0.83**	-	-	0.10	-	0.05	-	-	-	-	-	**0.02**	-	0.05	0.05	-	-	0.15	0.05	0.05
Coregonus sp.	**0.00**	0.05	-	-	-	-	-	-	-	-	-	**0.01**	-	-	-	-	-	-	-	-
Rainbow Smelt	**0.22**	-	-	-	-	-	0.05	-	0.05	-	0.10	**0.02**	-	-	-	-	-	-	-	-
Northern Pike	**0.08**	0.10	-	-	0.05	0.15	0.05	0.05	0.25	0.15	0.10	**0.09**	0.10	0.10	-	0.05	0.65	0.15	0.15	0.05
White Sucker	**0.98**	0.45	0.45	0.70	1.00	0.60	0.35	0.20	0.50	0.05	0.20	**0.45**	0.30	0.25	-	-	0.05	-	-	-
Brown Bullhead	**0.05**	-	0.05	0.05	0.05	0.05	-	0.05	-	-	-	**0.03**	-	-	-	-	-	-	-	-
Stonecat	**-**	0.05	0.05	-	-	-	-	-	-	-	-	**0.01**	-	-	-	-	-	-	-	-
Burbot	**0.02**	0.10	-	-	-	-	-	-	-	-	-	**0.01**	-	-	-	-	-	-	-	-
White Perch	**0.02**	-	-	0.10	-	-	-	-	-	-	-	**0.01**	-	-	-	-	-	-	-	-
Rock Bass	**0.87**	0.53	0.05	0.05	0.22	-	0.70	0.25	0.27	0.05	-	**0.21**	0.73	0.52	0.17	-	0.17	-	0.73	0.88
Smallmouth Bass	**0.06**	-	0.10	0.05	-	-	-	-	-	-	-	**0.02**	-	0.05	-	-	-	0.05	-	0.05
Yellow Perch	**22.70**	5.24	5.02	8.62	41.35	29.83	51.51	20.53	5.77	5.06	12.17	**18.51**	9.58	2.32	0.22	1.16	1.75	2.97	1.47	-
Walleye	**0.10**	-	-	-	-	0.05	0.05	0.05	0.10	0.15	0.25	**0.07**	0.10	0.10	-	-	0.15	0.10	-	0.05
Round Goby	**-**	-	-	-	0.99	4.96	12.26	8.18	1.70	0.50	2.81	**3.14**	1.49	3.97	0.17	-	0.50	0.99	2.31	1.49
Freshwater Drum	**0.08**	-	-	-	-	-	-	-	-	-	-	**-**	0.05	-	-	-	-	0.05	-	0.05
Total catch	**119**	60	14	19	149	179	269	172	308	314	638	**212**	923	828	341	15	298	493	891	137
Number of species	**10**	11	9	11	10	11	11	11	11	10	11	**11**	12	14	8	6	9	10	9	14
Number of sets		20	20	20	20	20	20	20	20	20	20		20	20	20	20	20	20	20	20

TABLE 1.1.7. Species-specific catch per gillnet set at **Grape Island in the Kingston Basin of Lake Ontario**, 1992-2018. Annual catches are averages for 1-3 gillnet gangs set at each of 5 depths (7.5, 12.5, 17.5, 22.5 and 27.5 m) during each of 2-3 visits during summer. Mean catches for 1992-2000 and 2001-2010 time-periods are shown in **bold**. The total number of species caught and gillnets set each year are indicated.

	1992-2000 mean	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	**2001-2010 mean**	2011	2012	2013	2014	2015	2016	2017	2018
Lake Sturgeon	**0.01**	0.05	-	0.05	-	-	-	-	-	-	-	**0.01**	-	-	-	-	-	-	-	-
Alewife	**116.14**	155.14	15.03	47.83	42.83	225.83	376.62	153.49	358.67	244.82	719.98	**234.02**	1,244.67	675.03	463.46	43.11	225.54	1,135.89	930.37	677.92
Chinook Salmon	**0.02**	-	-	-	-	0.15	-	0.10	-	-	-	**0.03**	-	-	-	-	-	-	-	0.10
Brown Trout	**0.02**	-	-	-	0.05	0.05	0.10	-	-	-	0.05	**0.03**	0.25	0.10	0.10	0.10	-	-	-	0.15
Lake Trout	**6.56**	0.30	0.57	0.45	0.10	0.15	0.15	0.57	0.05	0.40	0.20	**0.29**	0.20	0.20	1.78	2.27	1.70	0.25	0.35	0.72
Lake Whitefish	**2.86**	0.20	0.20	0.15	-	0.10	0.10	0.20	0.10	0.10	0.10	**0.13**	0.10	0.10	0.15	-	-	0.20	0.40	0.05
Cisco	**0.08**	-	-	-	-	-	-	-	-	-	0.15	**0.02**	0.05	-	0.10	0.05	-	0.40	0.25	0.32
Rainbow Smelt	**0.03**	-	-	-	-	-	-	-	-	0.05	-	**0.01**	-	-	-	-	-	-	-	-
Northern Pike	**-**	-	-	-	-	-	-	0.05	-	-	-	**0.01**	-	-	-	-	-	-	-	-
White Sucker	**0.04**	-	-	0.05	-	-	-	0.05	0.05	-	-	**0.02**	0.10	0.05	-	0.05	0.05	0.10	0.30	0.30
Silver Redhorse	**0.00**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Brown Bullhead	**-**	-	-	0.15	0.17	-	0.05	-	-	-	-	**0.04**	-	-	-	-	-	-	-	-
Channel Catfish	**0.02**	-	-	0.05	-	-	-	-	-	-	-	**0.01**	-	-	-	-	-	-	-	-
Stonecat	**0.04**	-	0.17	0.43	0.33	-	-	-	-	-	-	**0.09**	-	-	-	-	-	-	-	-
Burbot	**0.17**	-	0.10	0.05	-	-	-	-	-	-	-	**0.02**	-	-	-	-	-	-	-	-
Threespine Stickleback	**0.02**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
White perch	**0.07**	-	-	0.10	0.10	0.05	-	-	-	-	-	**0.03**	-	-	-	-	-	-	-	-
Rock Bass	**1.43**	1.01	0.05	0.72	0.33	0.17	0.37	0.93	1.01	0.43	0.35	**0.54**	0.05	0.80	0.20	0.05	0.17	0.22	0.05	0.38
Smallmouth Bass	**0.68**	0.15	0.48	0.47	0.48	0.05	0.52	0.15	0.35	0.32	0.25	**0.32**	0.50	0.85	0.50	0.27	0.45	0.60	0.70	2.02
Yellow Perch	**14.36**	3.54	19.72	18.54	45.07	12.18	18.13	15.82	7.44	6.98	6.91	**15.43**	4.61	0.98	2.63	1.37	2.25	1.70	2.88	2.29
Walleye	**2.90**	0.50	0.10	0.80	0.37	0.20	2.55	0.50	0.95	0.15	1.05	**0.72**	0.70	1.30	0.40	0.35	1.40	0.90	1.30	1.25
Round Goby	**-**	-	-	1.32	49.22	4.51	8.35	7.97	1.09	-	1.65	**7.41**	1.16	1.42	1.98	-	0.22	0.50	0.88	2.15
Freshwater Drum	**0.28**	0.05	-	0.20	-	-	0.05	-	0.05	-	0.05	**0.04**	-	-	-	-	-	-	-	0.10
Total catch	**146**	161	36	71	139	243	407	180	370	253	731	**259**	1,252	681	471	48	232	1,141	937	688
Number of species	**11**	9	9	16	11	11	11	11	10	8	11	**11**	11	10	10	9	8	10	10	13
Number of sets		20	20	20	20	20	20	20	20	20	20		20	20	20	20	20	20	20	20

TABLE 1.1.8. Species-specific catch per gillnet set at **Melville Shoal in the Kingston Basin of Lake Ontario**, 1992-2018. Annual catches are averages for 1-3 gillnet gangs set at each of 5 depths (7.5, 12.5, 17.5, 22.5 and 27.5 m) during each of 2-3 visits during summer. Mean catches for 1992-2000 and 2001-2010 time-periods are shown in **bold**. The total number of species caught and gillnets set each year are indicated.

	1992-2000 mean	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	**2001-2010 mean**	2011	2012	2013	2014	2015	2016	2017	2018
Lake Sturgeon	**0.01**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	0.05	-	-
Alewife	**71.63**	40.83	39.19	14.14	82.41	177.38	195.64	83.04	134.66	496.46	620.85	**188.46**	666.70	223.18	553.63	93.28	170.89	805.59	710.49	490.25
Gizzard Shad	**0.00**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Chinook Salmon	**0.03**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	0.05	-	0.05
Rainbow Trout	**-**	-	-	-	-	-	-	0.05	-	-	-	**0.01**	-	-	-	-	-	-	-	-
Brown Trout	**-**	-	-	-	-	-	0.05	-	0.10	-	0.15	**0.03**	0.05	0.05	-	0.05	-	-	-	-
Lake Trout	**3.54**	0.10	0.05	0.05	0.05	-	0.05	0.05	0.10	0.40	0.15	**0.10**	1.02	0.10	0.35	1.00	0.55	0.20	0.25	0.25
Lake Whitefish	**1.59**	0.10	0.20	0.30	-	-	-	0.05	-	-	-	**0.07**	-	-	-	-	-	-	-	-
Cisco	**0.04**	-	-	-	-	-	-	-	-	-	0.20	**0.02**	0.05	0.05	-	0.05	0.27	0.38	0.90	0.20
Coregonus sp.	**0.04**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Rainbow Smelt	**0.08**	-	-	-	-	-	-	-	0.17	-	0.05	**0.02**	-	-	-	-	-	-	-	-
Northern Pike	**0.07**	0.10	0.10	0.05	-	-	-	-	-	0.10	0.10	**0.05**	-	-	-	-	0.05	0.05	-	-
White Sucker	**0.03**	0.05	-	0.05	-	-	-	-	-	-	-	**0.01**	-	-	-	-	-	-	0.05	-
Greater Redhorse	**0.01**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Moxostoma sp.	**0.04**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Common Carp	**0.02**	-	-	0.05	0.10	-	-	-	0.05	-	-	**0.02**	-	-	-	-	-	-	-	-
Channel Catfish	**0.15**	-	-	0.05	-	-	-	-	-	-	-	**0.01**	-	-	-	-	-	-	-	-
Stonecat	**0.03**	0.33	0.43	-	-	0.50	-	-	-	-	-	**0.13**	-	-	-	-	-	-	-	-
Burbot	**0.10**	-	-	-	0.05	-	-	-	-	-	-	**0.01**	-	-	-	-	-	-	-	-
White Perch	**0.20**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Rock Bass	**1.88**	1.99	0.98	1.33	2.25	1.84	1.82	1.72	3.16	0.80	1.28	**1.72**	1.20	1.89	0.42	1.99	1.51	1.02	1.33	0.58
Pumpkinseed	**-**	0.17	-	-	-	-	-	-	-	-	-	**0.02**	-	-	-	-	-	-	-	-
Smallmouth Bass	**0.53**	0.42	0.25	0.40	0.27	0.15	0.20	0.57	0.70	0.25	0.60	**0.38**	0.40	1.00	-	0.87	0.10	0.20	0.70	0.37
Yellow Perch	**28.76**	12.57	26.57	20.20	49.72	16.14	44.66	38.74	18.75	9.75	25.97	**26.31**	10.38	8.82	3.92	12.58	6.03	6.11	13.68	7.33
Walleye	**8.73**	4.63	3.90	3.50	5.08	4.45	5.25	7.30	4.55	7.50	12.45	**5.86**	10.10	7.05	0.55	11.70	7.00	6.95	12.55	9.35
Round Goby	**-**	-	-	-	9.02	9.80	5.34	4.84	2.18	1.16	0.50	**3.28**	0.71	1.16	1.16	-	0.50	-	0.83	1.21
Freshwater Drum	**0.09**	0.05	-	0.05	-	-	-	0.22	-	-	0.10	**0.04**	0.05	-	-	-	0.05	-	-	-
Total catch	**118**	61	72	40	149	210	253	137	164	516	662	**227**	691	243	560	122	187	821	741	510
Number of species	**12**	12	9	12	9	7	8	10	10	8	12	**10**	10	9	6	8	10	10	9	9
Number of sets		20	20	20	20	20	20	20	20	20	20		20	20	20	20	20	20	20	20

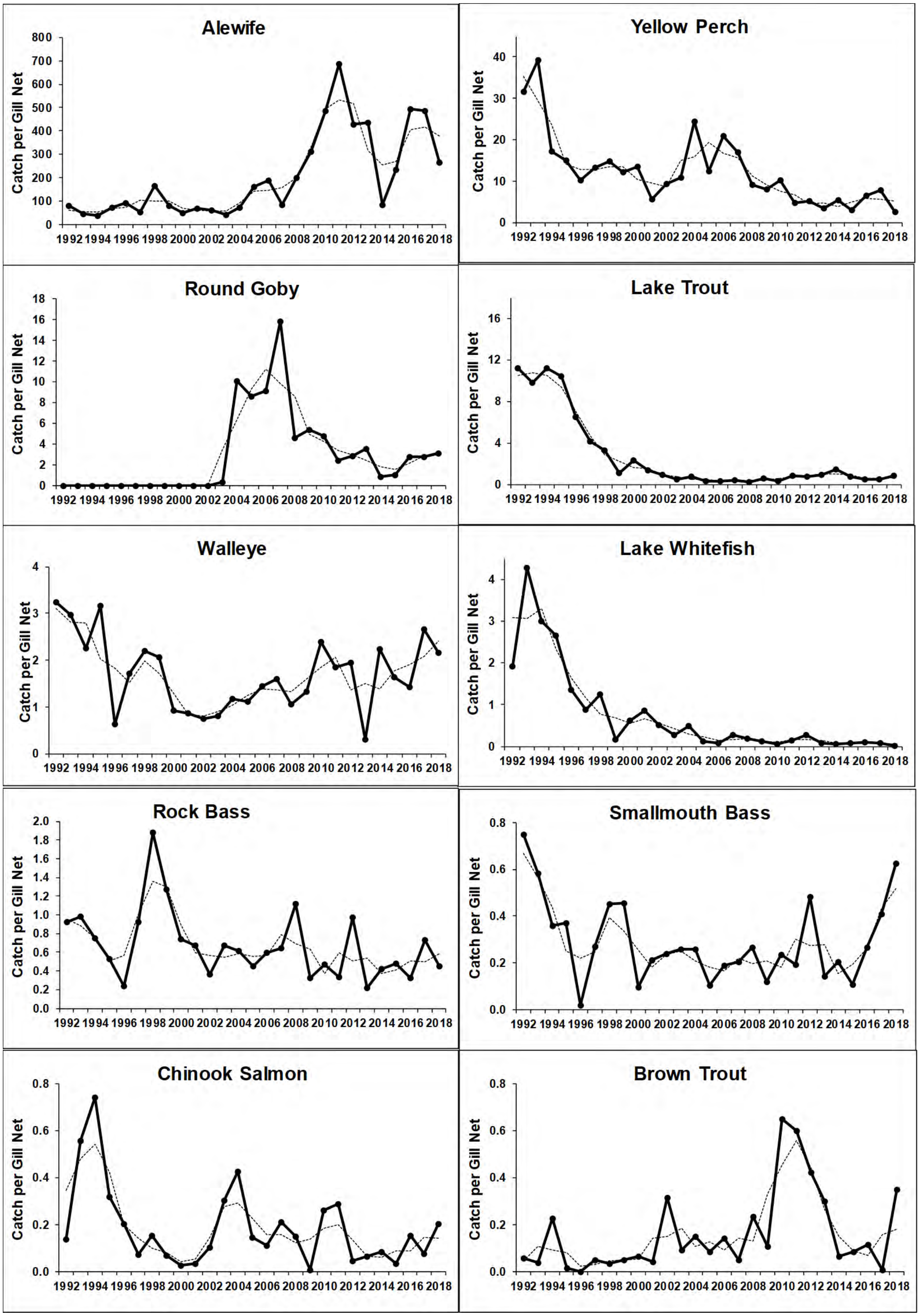


FIG. 1.1.2. Abundance trends for the most common species caught in gill nets at six depth-stratified transects (nearshore out to 30 m) in northeastern Lake Ontario (Melville Shoal, Grape Island, Flatt Point, Rocky Point, Wellington and Brighton; see Fig. 1.1.1). Annual catch per gill net values are unweighted means. Dotted lines show 3-yr running averages (two years for first and last years graphed).

TABLE 1.1.9. Species-specific catch per gill net set at **Middle Ground in Northeastern Lake Ontario**, 1992-2018 (no sampling in 2012). Annual catches are averages for 2 gill net gangs set during each of 1-3 visits during summer. Mean catches for 1992-2000 and 2001-2010 time-periods are shown in **bold**. The total number of species caught and gill nets set each year are indicated.

	1992-2000 mean	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	**2001-2010 mean**	2011	2012	2013	2014	2015	2016	2017	2018
Longnose Gar	**-**	-	-	0.25	-	-	-	-	-	-	-	**0.03**	-		-	-	-	-	-	-
Alewife	**3.61**	0.83	0.83	-	-	-	-	-	0.83	8.26	3.30	**1.40**	190.83		39.90	23.96	56.17	-	2.48	-
Gizzard Shad	**0.39**	-	-	-	-	0.50	-	0.25	-	-	0.25	**0.10**	-		-	-	-	-	0.25	2.25
Brown Trout	**0.11**	-	-	-	-	-	0.25	-	0.25	0.50	0.25	**0.13**	0.25		-	-	-	-	-	-
Lake Trout	**0.90**	-	-	-	-	-	0.25	-	-	-	-	**0.03**	-		-	-	-	-	-	-
Northern Pike	**0.34**	-	-	0.50	-	0.25	0.25	1.50	1.00	1.25	0.25	**0.50**	1.25		1.25	2.00	1.00	0.50	0.50	0.50
White Sucker	**1.40**	1.50	3.08	-	2.08	0.75	1.25	4.00	2.25	1.00	5.83	**2.17**	3.25		-	-	0.25	3.65	1.00	0.75
Silver redhorse	**-**	-	-	-	-	-	-	-	-	-	-	**-**	-		-	-	-	-	-	0.25
Common Carp	**0.41**	0.50	-	0.75	0.50	-	-	-	-	-	-	**0.18**	-		-	-	0.25	0.75	0.25	-
Brown Bullhead	**1.42**	2.00	0.50	2.15	0.25	1.58	0.83	0.75	0.25	-	-	**0.83**	0.25		-	-	-	-	0.25	-
White Perch	**0.08**	-	-	-	-	-	-	-	-	-	-	**-**	-		0.50	-	-	-	-	0.25
Rock Bass	**1.47**	1.08	0.25	0.50	0.75	0.50	-	1.08	-	-	0.25	**0.44**	-		0.25	-	-	1.65	1.08	0.25
Pumpkinseed	**0.18**	-	-	-	-	-	-	-	-	-	-	**-**	-		-	-	-	-	-	-
Bluegill	**0.06**	-	-	-	-	-	-	-	-	-	-	**-**	0.25		-	-	-	-	-	-
Smallmouth Bass	**0.02**	-	-	-	0.25	-	-	0.25	-	-	-	**0.05**	-		-	-	-	-	-	-
Largemouth Bass	**0.06**	-	-	-	-	-	-	-	-	-	-	**-**	-		-	-	-	-	-	-
Yellow Perch	**56.68**	43.38	60.90	25.86	68.12	29.34	105.73	29.26	44.35	22.65	13.64	**44.32**	68.09		80.52	25.53	43.78	75.99	38.12	10.86
Walleye	**2.44**	0.25	0.50	1.00	0.50	0.75	1.25	3.50	0.75	0.75	0.25	**0.95**	0.25		0.50	2.33	-	4.00	0.50	1.00
Freshwater Drum	**0.57**	-	0.25	-	3.00	0.25	-	0.50	-	0.50	-	**0.45**	-		-	-	-	0.25	-	1.50
Total catch	**70**	50	66	31	75	34	110	41	50	35	24	**52**	264		123	54	101	87	44	18
Number of species	**8**	7	7	7	8	8	7	9	7	7	8	**8**	8		6	4	5	7	9	9
Number of sets		4	4	4	4	4	4	4	4	4	4		4	-	4	4	4	4	4	4

TABLE 1.1.10. Species-specific catch per gillnet set at **EB02 in the Kingston Basin of Lake Ontario**, 1992-2018. Annual catches are averages for 3-8 gillnet gangs set during each of 2-3 visits during summer. Mean catches for 1992-2000 and 2001-2010 time-periods are shown in **bold**. The total number of species caught and gillnets set each year are indicated.

	1992-2000 mean	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	**2001-2010 mean**	2011	2012	2013	2014	2015	2016	2017	2018
Sea Lamprey	**0.01**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Lake Sturgeon	**0.01**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Alewife	**40.00**	17.83	0.25	0.25	8.67	1.75	4.50	3.25	2.92	7.46	157.00	**20.39**	2.45	60.75	9.13	1.50	15.21	356.88	30.95	2.94
Chinook Salmon	**0.05**	0.25	-	0.04	0.04	-	-	0.04	-	0.13	0.08	**0.06**	-	0.13	0.04	-	0.17	0.11	0.22	0.67
Rainbow Trout	**-**	-	-	-	-	-	-	-	-	-	-	**-**	0.04	-	-	-	-	-	-	-
Atlantic Salmon	**-**	-	-	-	-	-	-	-	0.04	-	-	**0.00**	-	-	-	-	-	-	-	-
Brown Trout	**0.02**	0.08	-	-	-	-	-	-	0.04	-	0.21	**0.03**	0.04	-	-	-	0.08	-	0.11	-
Lake Trout	**20.57**	1.58	0.75	1.54	0.88	0.42	1.50	2.08	3.58	2.33	1.63	**1.63**	2.10	0.88	2.38	4.17	4.88	1.78	2.73	2.70
Lake Whitefish	**3.76**	0.25	0.42	0.08	0.17	-	0.25	0.17	0.46	0.08	0.04	**0.19**	0.13	-	-	0.13	-	-	-	0.22
Cisco	**0.20**	-	-	-	0.04	-	-	-	-	-	0.21	**0.03**	0.04	-	0.08	-	0.21	1.00	0.67	0.11
Rainbow Smelt	**0.56**	-	-	-	0.04	0.04	0.08	0.04	-	0.17	0.17	**0.05**	-	-	0.04	-	0.04	-	-	-
Burbot	**0.05**	0.08	-	-	-	-	-	-	-	-	-	**0.01**	-	-	-	-	-	-	-	-
Trout-perch	**0.01**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
White Perch	**0.02**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Rock Bass	**-**	-	-	-	-	-	-	-	-	-	0.04	**0.00**	-	-	-	-	-	-	-	-
Smallmouth Bass	**-**	-	-	-	-	-	-	-	-	0.04	-	**0.00**	-	-	-	-	0.04	-	-	-
Yellow Perch	**0.09**	-	0.28	0.04	2.92	0.50	0.71	0.17	0.42	0.13	0.25	**0.54**	0.04	0.13	0.04	-	0.04	0.22	-	-
Walleye	**0.04**	-	-	-	0.04	-	-	-	0.04	-	-	**0.01**	-	-	-	-	-	-	-	-
Round Goby	**-**	-	-	-	0.13	0.04	0.17	0.08	-	-	0.04	**0.05**	-	-	0.04	0.04	-	-	-	-
Freshwater drum	**0.01**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Sculpin sp.	**0.01**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Total catch	**65**	20	2	2	13	3	7	6	8	10	160	**23**	5	62	12	6	21	360	35	7
Number of species	**7**	6	4	5	9	5	6	7	7	7	10	**7**	7	4	7	4	8	5	5	5
Number of sets		12	12	24	24	24	24	24	24	24	24		24	16	24	24	24	9	9	9

TABLE 1.1.11. Species-specific catch per gillnet set at **EB06 in the Kingston Basin of Lake Ontario**, 1992-2018. Annual catches are averages for 3-8 gillnet gangs set during each of 2-3 visits during summer. Mean catches for 1992-2000 and 2001-2010 time-periods are shown in **bold**. The total number of species caught and gillnets set each year are indicated.

	1992-2000 mean	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	**2001-2010 mean**	2011	2012	2013	2014	2015	2016	2017	2018
Sea Lamprey	**0.01**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Lake Sturgeon	**0.01**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Alewife	**28.50**	15.67	0.58	0.79	2.79	1.88	2.46	6.44	11.25	1.29	75.88	**11.90**	17.96	13.19	13.75	1.46	1.08	33.78	253.98	0.73
Chinook Salmon	**0.02**	-	-	-	-	0.08	-	-	0.04	-	-	**0.01**	0.08	0.19	0.08	-	-	0.11	-	-
Rainbow Trout	**-**	-	-	-	-	-	-	0.04	-	-	-	**0.00**	-	-	0.04	-	-	-	-	-
Brown Trout	**-**	-	0.08	-	-	0.04	-	0.08	0.04	0.04	0.04	**0.03**	-	0.13	-	-	0.04	-	-	-
Lake Trout	**21.88**	1.58	2.33	2.04	2.79	2.04	2.46	2.63	3.38	2.96	4.96	**2.72**	3.29	4.44	4.13	4.08	5.04	4.11	0.67	2.00
Lake Whitefish	**6.36**	0.58	0.42	0.25	2.54	0.29	0.33	0.42	1.79	0.46	0.92	**0.80**	0.92	0.75	0.50	0.13	0.17	0.11	0.11	-
Cisco	**0.03**	-	-	-	-	-	-	-	-	-	-	**-**	-	0.19	0.17	-	0.50	0.11	2.78	0.33
Rainbow Smelt	**0.52**	-	-	-	-	-	0.04	-	-	0.04	-	**0.01**	0.04	0.06	0.04	-	-	-	-	-
Common Carp	**-**	-	-	-	0.04	-	-	-	-	-	-	**0.00**	-	-	-	-	-	-	-	-
American Eel	**0.01**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Burbot	**0.13**	0.17	0.08	0.04	0.04	-	-	-	-	-	-	**0.03**	-	-	-	-	-	-	-	-
White Perch	**0.01**	-	-	0.04	-	-	-	-	-	-	-	**0.00**	-	-	-	-	-	-	-	-
Yellow Perch	**-**	-	-	0.04	-	-	-	-	0.21	-	-	**0.03**	-	-	-	-	-	-	-	-
Walleye	**0.01**	-	-	-	-	-	0.04	-	-	-	-	**0.00**	0.04	-	-	-	-	-	-	-
Round Goby	**-**	-	-	-	-	0.04	0.13	0.26	-	-	0.08	**0.05**	0.17	-	-	-	-	-	0.37	-
Lake Whitefish x Cisco	**-**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	0.11	-
Total catch	**57**	18	4	3	8	4	5	10	17	5	82	**16**	23	19	19	6	7	38	258	3
Number of species	**6**	4	5	6	5	6	6	6	6	5	5	**5**	7	7	7	3	5	5	6	3
Number of sets		12	12	24	24	24	24	24	24	24	24		24	16	24	24	24	9	9	9

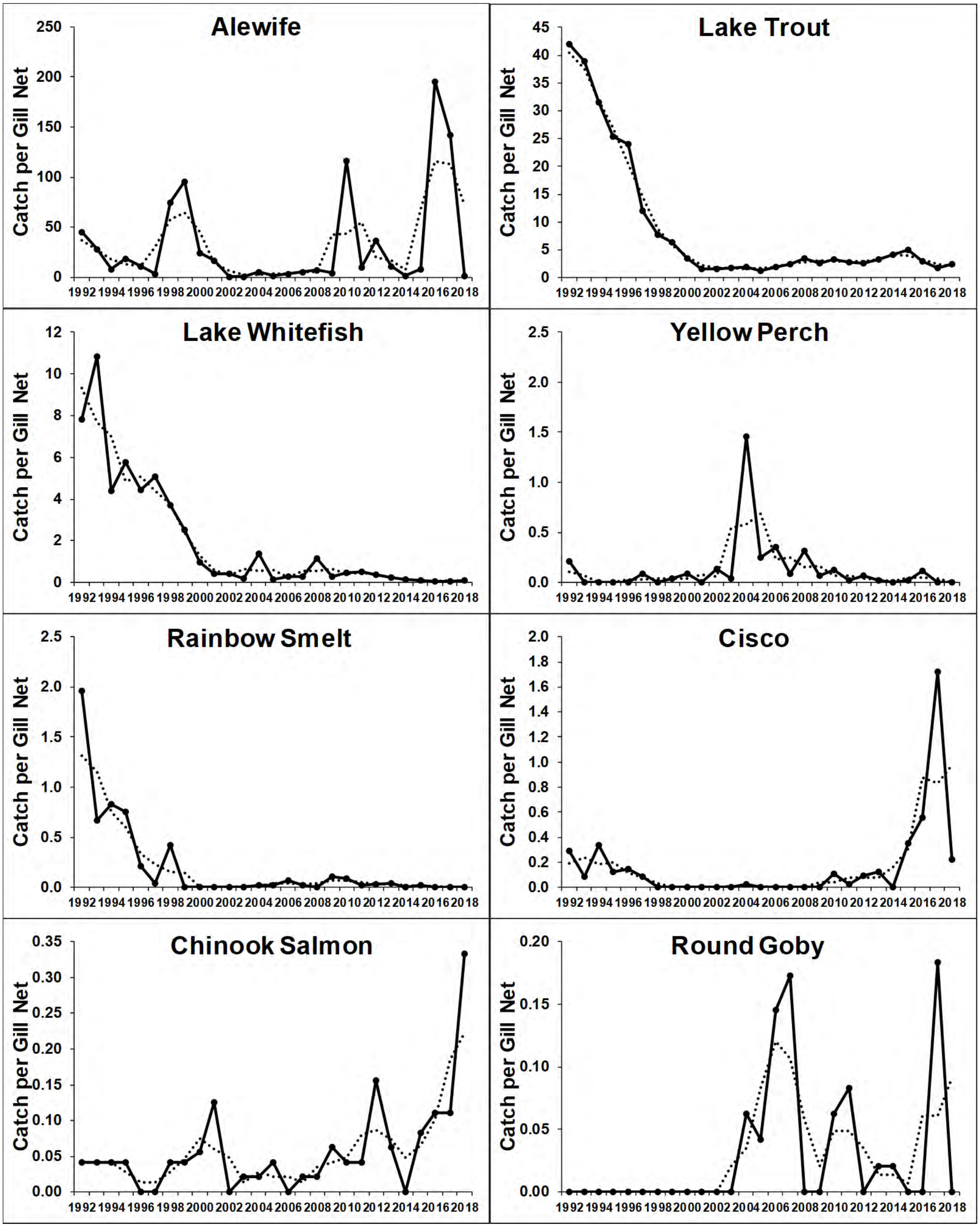


FIG. 1.1.3. Abundance trends (annual means) for the most common species caught in gill nets at the Kingston Basin deep sites, in eastern Lake Ontario (EB02 and EB06; see Fig. 1.1.1). Dotted lines show 3-yr running averages (two years for first and last years graphed).

Lake Trout, Lake Whitefish, Yellow Perch, Rainbow Smelt, Cisco, Chinook Salmon and Round Goby). Alewife catches were variable with high catches in some years: 1998-1999, 2010, 2012, 2016 and 2017. Lake Trout, Lake Whitefish, Rainbow Smelt, and Cisco abundance declined throughout the 1990s and remained low during the years that followed except that Cisco abundance increased markedly from 2014 to 2017 before declining in 2018. Chinook Salmon catches were relatively high in 2016 and 2017, and again in 2018. Round Goby catches continued to be highly variable.

Kingston Basin (additional sites sampled in 2017; Table 1.1.12)

As in 2016 and 2017, four additional Kingston Basin deep gill net sampling sites were netted in 2018; EB01, EB03, EB04 and EB05). The sampling included a seasonal component (Jun -Sep). Together, along with EB02 and EB06, this netting provided a more complete description of the Kingston Basin deep-water fish community (Table 1.1.12). Overall, the dominant species were Alewife, Lake Trout, and Cisco.

Lake-wide Depth Stratified Transects (Rocky Point, Cobourg, Port Credit; Tables 1.1.13-1.1.15)

In 2018, for the fifth consecutive year, three lake-wide depth-stratified gill net transects, spanning a wide depth range (7.5-140 m), were sampled. Alewife, Brown Trout, Lake Trout, White Sucker, and Round Goby were caught at three lake-wide transects. Cisco, Northern Pike, Smallmouth Bass, and Freshwater Drum were caught only in the eastern-most transect (Rocky Point). Coho Salmon, Rainbow Trout, and Burbot were caught only at the central transect (Cobourg). No species were unique to the west at Port Credit.

Rocky Point—Deep Sites (Table 1.1.16)

Ten species have been captured at the Rocky Point deep sampling sites since 1997. Alewife and Lake Trout were the two most abundant species. Lake Trout abundance was relatively stable from 1997-2002, declined significantly through 2004 and recovered in the years following. Round Goby appeared for the first time in 2012 (at the 60 m site) and were captured again in 2015 and 2016 but not in 2017 or 2018. Unlike Cobourg and Port Credit deep gill net sites (see below), Deepwater Sculpin had never been caught in the Rocky Point gill net sites but were caught in 2015 and in 2017.

Cobourg (Tables 1.1.17 and 1.1.18)

Nearshore sites (7.5-27.5 m): Alewife dominated the catch at the Cobourg nearshore sites but the salmonid fish community was also well represented (Table 1.1.17). Ten species were caught in 2018. Alewife catch declined significantly from 2010-2014, increased in 2015 and 2016, and remained high in 2017 and 2018.

Deep sites (40-140 m): Three species were caught at the Cobourg deep sites in 2018: Alewife, Lake Trout, and Deepwater Sculpin (Table 1.1.18).

Port Credit (Tables 1.1.19 and 1.1.20)

Port Credit was sampled for the first time in 2014; sampling occurred again each year since with two additional deep sampling depths added (40 and 50 m) in 2016.

Nearshore sites (7.5-27.5 m): Six species were caught in 2018. Alewife dominated the catch. Other species caught included Round Goby, Rock Bass, White Sucker, Lake Trout, and Brown Trout (Table 1.1.19).

Deep Sites (40-140 m): Three species were caught at the Port Credit deep sites: Alewife, Lake Trout, and Deepwater Sculpin (Table 1.1.20).

Bay of Quinte (Conway, Hay Bay and Big Bay; Tables 1.1.21-1.1.23 inclusive)

Three sites are used to monitor long-term trends in the Bay of Quinte fish community. Big Bay is a single-depth site; Hay Bay has two depths and Conway five depths. Average summer catch for the three sites are summarized graphically in Fig. 1.1.4 to illustrate abundance trends of the most abundant species from 1992-2018. Yellow Perch abundance peaked in 1998, declined gradually through 2013, and generally increased over the last five years. In 2014, White Perch abundance declined to its lowest level since 2001 and has recovered since. Alewife abundance increased from 2007-2010, declined from 2010-2014, and increased significantly through 2016. Alewife catch was low in 2017 and 2018. Walleye

TABLE 1.1.12. Species-specific catch per gillnet set at **six sites (EB01, EB02, EB03, EB04, EB05, EB06) in the Kingston Basin of Lake Ontario**, 2018. Catches are averages for 3 gillnet gangs set during each of 3 visits during summer. The total number of species caught and gillnets set each year are indicated.

	EB01			EB02			EB03			EB04			EB05			EB06			All sites
Species	Jun	Aug	Sep	Jun	Aug	Sep	Jun	Aug	Sep	Jun	Aug	Sep	Jun	Aug	Sep	Jun	Aug	Sep	Mean
Lake Sturgeon	-	-	-	-	-	-	0.33	-	-	-	-	-	-	-	-	-	-	-	0.02
Alewife	2.54	8.81	-	-	8.81	-	-	6.61	-	23.13	34.48	22.03	29.30	-	5.51	2.20	-	-	7.97
Chinook Salmon	-	0.33	0.33	-	0.33	1.67	0.33	0.67	0.33	-	0.67	0.33	-	-	-	-	-	-	0.28
Brown Trout	-	-	-	-	-	-	-	-	0.67	-	0.33	-	-	-	-	-	-	-	0.06
Lake Trout	3.67	0.33	2.33	3.00	1.00	4.10	1.67	1.00	1.67	3.33	2.00	-	0.33	0.67	-	2.00	1.67	2.33	1.73
Lake Whitefish	-	-	0.33	0.33	-	0.33	-	-	0.33	-	3.00	-	-	-	-	-	-	-	0.24
Cisco	-	-	1.43	-	-	0.33	-	0.33	0.67	0.33	10.67	3.33	-	0.33	3.67	-	0.33	0.67	1.23
Rainbow Smelt	-	-	0.33	-	-	-	-	-	-	-	-	2.20	-	-	1.10	-	-	-	0.20
Yellow Perch	-	-	-	-	-	-	-	-	-	-	-	2.87	-	-	-	-	-	-	0.16
Walleye	-	-	-	-	-	-	-	-	0.33	-	-	-	-	-	0.33	-	-	-	0.04
Round Goby	-	-	-	-	-	-	-	-	-	-	-	2.20	2.20	-	1.10	-	-	-	0.31
Lake Whitefish x Cisco	-	-	-	-	-	-	-	-	-	-	-	0.33	-	-	-	-	-	-	0.02
Total catch	6	9	5	3	10	6	2	9	4	27	51	33	32	1	12	4	2	3	12
Number of species	2	3	5	2	3	4	3	4	6	3	6	7	3	2	5	2	2	2	12
Number of sets	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	54

TABLE 1.1.13. Species-specific catch per gillnet set at **Rocky Point in northeastern Lake Ontario** by site depth, 2018. Catches are averages for 2 or 3 gill net gangs during each of 1 or 2 visits during summer. The total number of species caught and number of gill nets set are indicated.

	Northeast (Rocky Point)										
Site depth (m)	7.5	12.5	17.5	22.5	27.5	40	50	60	80	100	140
Alewife	115.08	45.03	26.68	462.15	185.57	44.00	17.33	25.00	21.33	22.33	6.33
Chinook Salmon	0.00	0.00	0.50	0.75	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Brown Trout	0.00	0.00	3.75	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lake Trout	0.00	0.00	0.25	0.50	4.40	8.33	6.00	1.33	1.00	0.00	0.00
Cisco	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Northern Pike	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
White Sucker	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rock Bass	1.08	1.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Smallmouth Bass	5.58	1.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Walleye	5.75	3.15	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Round Goby	0.83	1.90	0.00	33.87	9.09	0.00	0.00	0.00	0.00	0.00	0.00
Freshwater Drum	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total catch	129	52	32	498	200	52	23	26	22	22	6
Number of species	7	5	6	4	4	2	2	2	2	1	1
Number of sets	4	4	4	4	4	3	3	3	3	3	3

TABLE 1.1.14. Species-specific catch per gillnet set at **Cobourg in north central Lake Ontario** by site depth, 2018. Catches are averages for 2 or 3 gill net gangs during each of 1 or 2 visits during summer. The total number of species caught and number of gill nets set are indicated.

	North Central (Cobourg)										
Site depth (m)	7.5	12.5	17.5	22.5	27.5	40	50	60	80	100	140
Alewife	256.34	466.18	258.68	93.29	35.77	209.61	62.67	80.00	36.67	52.67	10.67
Coho Salmon	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chinook Salmon	0.75	0.25	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rainbow Trout	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Brown Trout	1.00	1.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lake Trout	0.25	0.00	1.00	2.75	5.00	0.33	2.00	0.33	0.00	0.00	0.00
White Sucker	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Burbot	0.00	0.25	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Walleye	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Round Goby	3.30	0.83	12.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Deepwater Sculpin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67
Total catch	263	469	273	96	41	210	65	80	37	53	11
Number of species	7	5	7	3	2	2	2	2	1	1	2
Number of sets	4	4	4	4	4	3	3	3	3	3	3

TABLE 1.1.15. Species-specific catch per gillnet set at **Port Credit in northwestern Lake Ontario** by site depth, 2018. Catches are averages for 2 or 3 gill net gangs during each of 1 or 2 visits during summer. The total number of species caught and number of gill nets set are indicated.

	Northwest (Port Credit)										
Site depth (m)	7.5	12.5	17.5	22.5	27.5	40	50	60	80	100	140
Alewife	186.95	16.77	50.32	121.36	125.74	7.00	7.33	14.00	8.00	4.33	1.67
Brown Trout	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lake Trout	0.00	0.00	0.25	0.00	0.50	2.00	2.33	1.00	1.00	0.00	0.00
White Sucker	0.50	0.25	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rock Bass	1.08	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Round Goby	2.48	0.00	4.13	28.91	3.30	0.00	0.00	0.00	0.00	0.00	0.00
Deepwater Sculpin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00
Total catch	191	17	55	151	130	9	10	15	9	4	7
Number of species	4	3	4	3	3	2	2	2	2	1	2
Number of sets	4	4	4	4	4	3	3	3	3	3	3

TABLE 1.1.16. Species-specific catch per gillnet set at **Rocky Point (deep sites only) in northeastern Lake Ontario**, 1997-2018 (no sampling in 2006, 2007 or 2010). Annual catches are averages for 2 or 3 gillnet gangs set at each of up to 6 depths (40, 50, 60, 80, 100 or 140 m) during each of 2 visits during early-summer. Mean catches for 1997-2000 and 2001-2010 time-periods are shown in bold. The total number of species caught and gillnets set each year are indicated.

	1997-2000 mean	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	**2001-2010 mean**	2011	2012	2013	2014	2015	2016	2017	2018
Alewife	**4.69**	12.25	0.38	9.21	14.46	1.83			23.92	40.67		**14.67**	35.13	2.58	13.50	41.46	62.71	42.22	7.28	22.72
Lake Trout	**5.05**	6.81	6.25	4.17	2.17	1.83			1.46	1.88		**3.51**	2.42	2.00	5.92	1.46	4.00	7.33	5.11	2.78
Lake Whitefish	**0.50**	0.13	-	0.08	-	0.08			0.25	0.50		**0.15**	0.13	-	0.67	0.67	0.29	0.39	-	-
Cisco	**0.13**	-	0.13	0.08	0.21	-			-	-		**0.06**	-	-	-	0.04	0.04	-	-	-
Coregonus sp.	**-**	-	-	-	-	-			-	-		**-**	-	-	-	-	0.04	-	-	-
Rainbow Smelt	**0.41**	-	0.19	-	-	-			0.08	0.08		**0.05**	0.08	-	0.08	0.13	-	-	-	-
Burbot	**0.09**	-	-	-	0.04	-			-	-		**0.01**	-	-	-	-	-	-	-	-
White Perch	**-**	-	-	-	-	-			-	-		**-**	-	-	-	-	-	0.06	-	-
Round Goby	**-**	-	-	-	-	-			-	-		**-**	-	0.08	-	-	0.04	0.22	-	-
Slimy Sculpin	**0.08**	0.06	-	0.04	0.04	-			0.08	-		**0.03**	-	-	-	-	-	-	-	-
Deepwater Sculpin	**-**	-	-	-	-	-			-	-		**-**	-	-	-	-	0.04	-	0.17	-
Total catch	**11**	19	7	14	17	4			26	43		**18**	38	5	20	44	67	50	12	26
Number of species	**6**	4	4	5	5	3			5	4		**4**	4	3	4	5	7	5	3	2
Number of sets		16	16	24	24	24	-	-	24	24	-		24	12	12	24	24	18	18	18

TABLE 1.1.17. Species-specific catch per gill net set at **Cobourg (nearshore sites only) in northeastern Lake Ontario**, 2010-2018. Annual catches are averages for 2 gill net gangs set at each of 5 depths (7.5, 12.5, 17.5, 22.5 and 27.5 m) during each of 1-3 visits during summer. The total number of species caught and gill nets set each year are indicated.

	2010	2011	2012	2013	2014	2015	2016	2017	2018
Alewife	351.96	196.13	56.77	23.78	7.48	136.71	271.45	200.83	222.05
Gizzard Shad	-	-	-	-	-	-	0.05	-	-
Coho Salmon	-	-	0.10	-	0.05	-	0.25	-	0.05
Chinook Salmon	0.68	2.05	1.82	0.44	0.40	0.20	1.70	0.05	0.30
Rainbow Trout	0.51	0.25	0.80	0.05	-	-	0.10	-	0.10
Brown Trout	0.13	0.65	0.50	0.42	0.25	0.40	0.65	0.05	0.45
Lake Trout	0.37	0.05	-	1.26	0.70	0.37	0.10	0.52	1.80
Lake Whitefish	-	0.05	-	-	-	-	0.05	-	-
Cisco	-	-	-	-	-	-	0.05	-	
Round Whitefish	0.07	0.05	-	-	-	-	-	-	-
Rainbow Smelt	-	0.33	-	-	-	-	-	-	-
White Sucker	0.10	0.37	0.50	0.26	0.15	0.20	0.05	-	0.10
Greater Redhorse	-	-	0.10	-	-	-	-	-	-
Burbot	-	-	-	-	0.05	-	-	-	0.10
Smallmouth Bass	-	0.05	-	-	-	-	-	0.05	-
Yellow Perch	0.33	-	0.10	-	-	-	-	0.05	-
Walleye	0.03	-	0.40	-	0.05	0.10	0.10	0.05	0.05
Round Goby	2.20	9.91	3.30	0.40	0.17	1.65	2.20	6.61	3.30
Freshwater Drum	-	0.05	0.10	-	-	-	-	-	-
Total catch	356	210	65	27	9	140	277	208	228
Number of species	10	12	11	7	9	7	12	8	10
Number of sets	30	20	10	19	20	20	20	20	20

TABLE 1.1.18. Species-specific catch per gill net set at **Cobourg (deep sites only) in northeastern Lake Ontario**, 1997, 1998, and 2014-2018. Annual catches are averages for 2 or 3 gill net gangs set at each of 4-6 depths (40, 50, 60, 80, 100 and 140 m) during each of 1-2 visits during summer. The total number of species caught and gill nets set each year are indicated.

	1997	1998	2014	2015	2016	2017	2018
Alewife	67.16	42.75	29.75	171.50	23.00	338.18	75.38
Brown Trout	-	-	0.08	-	-	-	-
Lake Trout	0.50	0.88	0.17	0.42	3.11	1.11	0.44
Cisco	-	0.13	-	-	0.17	-	-
Rainbow Smelt	2.88	0.50	-	-	-	-	-
Round Goby	-	-	-	-	-	0.06	-
Slimy Sculpin	0.06	-	-	-	-	-	-
Deepwater Sculpin	-	-	3.67	0.25	0.89	0.61	0.11
Total catch	71	44	30	172	26	339	76
Number of species	4	4	4	3	4	4	3
Number of sets	16	16	12	12	18	18	-

TABLE 1.1.19. Species-specific catch per gill net set at **Port Credit (nearshore sites only) in northwestern Lake Ontario**, 2014-2018. Annual catches are averages for 2 gillnet gangs set at each of 5 depths (7.5, 12.5, 17.5, 22.5 and 27.5 m) during summer. The total number of species caught and gillnets set each year are indicated.

	2014	2015	2016	2017	2018
Sea Lamprey	-	-	-	0.10	-
Alewife	24.12	358.58	234.44	315.76	100.23
Gizzard Shad	-	-	-	0.10	-
Chinook Salmon	0.10	0.20	0.10	0.50	-
Rainbow Trout	-	-	-	0.20	-
Atlantic Salmon	-	0.10	-	-	-
Brown Trout	-	0.10	-	0.40	0.05
Lake Trout	1.20	0.80	0.20	0.10	0.15
Longnose Sucker	-	0.20	0.10	-	-
White Sucker	0.20	1.50	0.20	0.60	0.25
White Perch	-	-	-	0.10	-
Rock Bass	-	-	-	0.10	0.27
Round Goby	-	1.32	5.72	6.58	7.77
Total catch	26	361	235	318	101
Number of species	4	8	6	11	6
Number of sets	10	10	10	10	10

TABLE 1.1.20. Species-specific catch per gill net set at **Port Credit (deep sites only) in northwestern Lake Ontario**, 2014-2018. Annual catches are averages for 3 gillnet gangs set at each of 4-6 depths (40, 50, 60, 80, 100, and 140 m) during summer. The total number of species caught and gillnets set each year are indicated.

	2014	2015	2016	2017	2018
Alewife	79.92	7.33	4.33	39.11	7.06
Chinook Salmon	-	-	0.06	-	-
Lake Trout	1.17	1.42	2.94	1.00	1.06
Burbot	-	-	0.06	-	-
Round Goby	-	-	-	0.33	-
Deepwater Sculpin	2.00	1.42	2.06	1.00	0.83
Total catch	83	10	9	41	9
Number of species	3	3	5	4	3
Number of sets	12	12	18	18	18

TABLE 1.1.21. Species-specific catch per gillnet set at **Conway in the Bay of Quinte**, 1993-2018. Annual catches are averages for 2-3 gillnet gangs set at each of 5 depths (7.5, 12.5, 20, 30 and 45 m) during each of 2-3 visits during summer. Mean catches for 1993-2000 and 2001-2010 time-periods are shown in **bold**. The total number of species caught and gillnets set each year are indicated.

	1993-2000 mean	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	**2001-2010 mean**	2011	2012	2013	2014	2015	2016	2017	2018
Sea Lamprey	**0.00**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	0.05	-	-	-	-
Lake Sturgeon	**0.00**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	0.05	-	-
Longnose Gar	**0.00**	0.05	-	-	-	-	-	-	-	-	-	**0.01**	-	-	-	-	-	-	-	-
Alewife	**46.74**	8.25	2.90	6.00	16.20	69.45	11.55	19.35	71.00	74.95	175.35	**45.50**	176.44	112.70	86.30	54.60	137.08	468.20	37.10	4.12
Gizzard Shad	**0.01**	-	-	-	0.05	-	-	0.20	0.10	-	-	**0.04**	0.10	-	-	-	-	-	0.05	-
Chinook Salmon	**0.03**	0.05	-	0.05	0.10	-	-	0.10	0.10	0.10	0.05	**0.06**	0.15	-	-	0.10	0.10	-	0.17	0.17
Rainbow Trout	**-**	-	-	-	-	0.05	-	-	-	-	-	**0.01**	-	-	-	-	-	-	-	-
Atlantic Salmon	**0.01**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Brown Trout	**0.29**	0.10	0.05	0.35	0.10	0.25	0.25	0.15	0.45	0.15	0.05	**0.19**	0.40	-	0.05	-	-	-	-	0.05
Lake Trout	**2.02**	0.75	2.30	1.75	2.05	2.75	1.15	1.35	0.95	0.10	0.15	**1.33**	0.95	1.80	2.25	2.80	1.65	3.15	1.78	2.12
Lake Whitefish	**0.96**	0.45	0.25	0.75	0.10	0.60	0.30	0.25	0.20	0.05	0.20	**0.32**	0.30	0.20	0.40	0.05	0.15	0.55	0.15	0.15
Cisco	**0.19**	0.20	-	-	-	-	0.05	-	0.10	0.05	0.15	**0.06**	-	0.15	-	-	0.45	0.75	0.58	-
Coregonus sp.	**0.00**	-	-	-	0.05	-	-	-	-	-	-	**0.01**	-	-	-	0.05	-	-	-	-
Rainbow Smelt	**0.08**	0.20	-	-	0.05	0.20	0.05	-	0.35	0.10	0.15	**0.11**	0.10	-	0.10	-	0.25	0.10	0.43	0.05
Northern Pike	**0.04**	0.05	-	0.05	-	-	-	0.05	0.05	-	0.05	**0.03**	-	-	-	0.10	-	-	-	-
White Sucker	**2.36**	3.30	2.60	2.15	1.05	0.60	0.45	1.45	0.55	0.30	0.20	**1.27**	0.05	0.05	0.10	0.10	0.05	0.55	0.50	0.45
Silver Redhorse	**0.01**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Moxostoma sp.	**0.01**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Common Carp	**0.04**	-	-	-	-	-	-	0.05	-	-	-	**0.01**	-	-	-	-	-	-	-	-
Brown Bullhead	**0.05**	0.05	-	0.10	0.20	0.15	0.90	0.35	-	-	-	**0.18**	0.05	-	-	-	-	-	-	-
Channel Catfish	**0.02**	0.05	0.05	-	-	0.05	-	-	-	-	-	**0.02**	-	-	-	-	-	-	-	-
Stonecat	**-**	0.05	0.05	-	-	-	-	-	-	-	-	**0.01**	-	-	-	-	-	-	-	-
Burbot	**0.02**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Trout-perch	**0.01**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
White Perch	**1.95**	-	0.05	0.85	2.65	-	0.85	1.25	1.15	0.15	0.05	**0.70**	0.50	0.30	2.30	-	0.05	0.05	0.82	4.44
White Bass	**-**	-	-	-	-	-	-	-	-	-	-	**-**	0.05	-	-	-	-	-	-	0.15
Morone sp.	**-**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	0.05	-
Rock Bass	**2.19**	0.45	0.90	0.15	0.15	0.50	0.95	3.85	2.05	0.20	0.95	**1.02**	0.95	0.05	0.40	0.40	0.30	1.00	0.10	0.60
Pumpkinseed	**0.03**	0.05	0.05	0.05	-	-	-	0.05	-	-	-	**0.02**	-	-	-	-	-	-	-	-
Smallmouth Bass	**0.31**	0.05	-	-	-	0.05	0.15	0.15	0.05	-	0.15	**0.06**	0.10	0.10	0.05	-	-	-	0.10	0.05
Yellow Perch	**84.25**	65.50	77.50	48.65	33.15	28.00	57.25	18.20	26.10	11.60	16.25	**38.22**	25.75	11.40	25.60	7.10	3.00	12.65	95.87	29.94
Walleye	**8.23**	1.00	1.45	2.70	1.05	1.25	1.90	2.50	1.60	1.40	1.25	**1.61**	2.10	0.60	1.00	0.35	0.80	0.65	6.90	4.30
Round Goby	**-**	-	1.00	11.00	31.05	0.80	0.15	0.10	0.25	-	0.05	**4.44**	-	0.05	-	-	-	-	-	-
Freshwater Drum	**0.54**	0.05	0.10	0.15	0.65	0.50	1.20	1.35	0.75	0.40	0.75	**0.59**	3.25	0.10	0.40	0.05	-	0.05	1.40	1.70
Total catch	**150**	81	89	75	89	105	77	51	106	90	196	**96**	211	128	119	66	144	488	146	48
Number of species	**13**	19	14	15	15	15	15	18	17	13	16	**16**	16	12	12	11	11	12	14	14
Number of sets		20	20	20	20	20	20	20	20	20	20		20	20	20	20	20	20	20	20

TABLE 1.1.22. Species-specific catch per gillnet set at **Hay Bay in the Bay of Quinte**, 1992-2018. Annual catches are averages for 1-3 gillnet gangs set at each of 2 depths (7.5 and 12.5 m) during each of 1-3 visits during summer. Mean catches for 1992-2000 and 2001-2010 time-periods are shown in **bold**. The total number of species caught and gillnets set each year are indicated.

	1992-2000 mean	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	**2001-2010 mean**	2011	2012	2013	2014	2015	2016	2017	2018
Sea Lamprey	**-**	-	-	-	-	-	-	-	0.13	-	-	**0.01**	-	-	-	-	-	-	-	-
Lake Sturgeon	**0.01**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Longnose Gar	**-**	-	-	-	-	-	-	0.13	-	-	-	**0.01**	-	-	-	-	-	-	-	-
Alewife	**8.33**	19.25	8.13	-	1.25	0.25	7.50	3.75	0.13	9.75	28.75	**7.88**	12.00	5.38	3.75	4.88	13.13	57.25	4.27	46.63
Gizzard Shad	**0.71**	-	0.25	-	-	-	0.50	0.13	0.13	-	-	**0.10**	-	0.38	5.38	-	1.25	-	-	0.17
Chinook Salmon	**0.04**	-	-	-	-	-	-	-	-	-	-	**-**	-	0.13	-	-	0.13	-	-	-
Rainbow Trout	**-**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	0.08	-	-
Brown Trout	**0.01**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
Lake Trout	**0.12**	-	-	0.25	-	-	-	-	-	-	-	**0.03**	-	-	-	-	-	0.33	0.08	-
Lake Whitefish	**0.06**	0.13	-	-	-	-	-	-	-	-	-	**0.01**	-	-	-	-	-	0.08	-	0.08
Cisco	**3.79**	1.00	0.13	-	0.13	-	-	0.13	-	0.13	10.25	**1.18**	0.38	0.25	-	-	-	0.42	0.67	0.58
Coregonus sp.	**0.04**	-	-	-	-	-	-	-	0.13	-	-	**0.01**	-	-	-	-	-	-	-	-
Rainbow Smelt	**0.19**	-	0.25	-	-	-	0.13	-	-	0.38	-	**0.08**	-	-	-	-	0.13	-	-	-
Northern Pike	**1.00**	0.88	0.13	0.38	-	0.50	0.38	1.13	1.00	0.50	3.00	**0.79**	0.38	0.13	-	0.25	0.13	0.67	0.50	1.19
White Sucker	**6.12**	5.63	2.88	2.25	6.13	1.50	1.75	1.38	2.50	4.25	8.75	**3.70**	2.25	2.75	0.88	5.38	3.38	3.92	8.75	6.25
River Redhorse	**-**	-	-	-	-	-	-	0.13	-	-	-	**0.01**	-	-	-	-	-	-	-	-
Common Carp	**0.23**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	0.13	-	-	-	-	-
Golden Shiner	**-**	-	-	-	-	-	-	-	-	-	-	**-**	-	0.25	0.13	-	0.50	1.33	-	0.08
Spottail Shiner	**0.01**	-	-	-	-	-	-	0.13	-	-	-	**0.01**	-	-	-	-	-	-	-	-
Brown Bullhead	**0.94**	0.88	0.13	0.25	0.25	0.38	0.88	0.38	0.50	-	-	**0.36**	-	-	-	0.25	0.13	-	-	-
Channel Catfish	**0.01**	-	-	0.13	0.13	-	-	-	-	-	-	**0.03**	-	-	-	-	-	-	-	-
Burbot	**0.04**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
White Perch	**11.00**	0.50	5.38	8.38	14.50	0.13	30.13	16.25	20.75	9.38	1.75	**10.71**	4.00	7.88	55.63	1.00	0.63	2.92	3.16	28.57
White bass	**-**	-	-	-	-	-	-	-	-	-	-	**-**	-	0.13	-	-	-	0.25	0.25	0.33
Rock Bass	**0.03**	-	-	-	-	-	-	-	0.13	-	-	**0.01**	-	-	-	-	-	-	-	-
Pumpkinseed	**0.86**	1.13	1.00	0.63	2.13	0.38	0.63	0.75	0.75	0.75	0.75	**0.89**	0.75	-	-	0.50	-	0.08	0.33	2.08
Bluegill	**-**	-	-	-	-	-	-	-	-	-	-	**-**	0.13	-	-	-	-	-	-	-
Smallmouth Bass	**0.10**	0.13	0.13	-	-	-	-	-	-	-	-	**0.03**	-	-	-	-	-	-	-	-
Black Crappie	**-**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	0.13	-	-	0.08	-	-
Yellow Perch	**154.09**	144.13	112.13	110.50	86.00	142.75	64.00	102.00	98.88	81.63	210.00	**115.20**	94.63	35.75	6.13	53.50	37.25	113.58	99.64	91.02
Walleye	**4.39**	2.50	3.75	2.75	2.13	0.88	1.75	2.50	1.13	2.75	2.00	**2.21**	1.50	1.25	2.88	2.13	0.75	2.00	3.08	2.88
Round Goby	**-**	-	0.25	0.25	0.25	0.13	-	-	-	-	-	**0.09**	-	-	-	-	-	-	-	-
Freshwater Drum	**1.08**	0.25	3.13	1.25	6.63	2.50	8.25	1.00	0.88	1.00	0.75	**2.56**	0.25	0.63	3.88	2.75	0.13	0.42	2.94	1.92
Total catch	**193**	176	138	127	120	149	116	130	127	111	266	**146**	116	55	79	71	58	183	124	182
Number of species	**14**	12	14	11	11	10	11	14	13	10	9	**12**	10	12	10	9	12	15	11	13
Number of sets		8	8	8	8	8	8	8	8	8	4		8	8	8	8	8	12	12	12

TABLE 1.1.23. Species-specific catch per gillnet set at **Big Bay in the Bay of Quinte**, 1992-2018. Annual catches are averages for 2 gillnet gangs set during each of 2-4 visits during summer. Mean catches for 1992-2000 and 2001-2010 time-periods are shown in **bold**. The total number of species caught and gillnets set each year are indicated.

	1992-2000 mean	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	**2001-2010 mean**	2011	2012	2013	2014	2015	2016	2017	2018
Lake Sturgeon	**0.02**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	0.17
Longnose Gar	**1.39**	1.00	1.00	0.17	1.00	1.50	3.00	0.33	2.50	3.77	6.50	**2.08**	2.33	3.83	12.83	0.17	1.67	3.63	3.75	2.49
Alewife	**0.70**	-	0.88	1.67	3.17	-	0.75	-	1.00	2.67	1.00	**1.11**	0.50	0.50	0.17	2.17	2.17	2.38	3.47	1.27
Gizzard Shad	**7.23**	2.13	6.63	2.00	0.17	42.17	0.25	1.00	3.67	-	3.33	**6.13**	88.50	10.83	-	-	1.50	3.75	2.17	0.17
Lake Whitefish	**-**	-	-	-	-	-	-	-	-	-	-	**-**	-	0.17	-	-	-	-	-	-
Northern Pike	**0.68**	0.13	0.13	-	0.17	0.17	0.50	0.17	-	-	-	**0.13**	-	-	-	-	-	0.25	0.17	0.17
Mooneye	**0.04**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
White Sucker	**7.30**	3.50	9.25	2.33	5.33	2.50	5.00	2.50	4.33	3.33	3.67	**4.18**	4.00	7.00	5.50	3.50	7.00	4.13	8.50	9.67
Silver Redhorse	**-**	-	-	-	-	-	-	-	-	-	0.17	**0.02**	-	-	-	-	-	-	-	0.17
Shorthead Redhorse	**-**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	0.13	-	-
Moxostoma sp.	**0.04**	0.13	-	0.17	-	-	-	-	-	-	-	**0.03**	-	-	-	-	-	-	-	-
Common Carp	**0.30**	-	-	0.17	0.17	-	-	-	-	-	-	**0.03**	-	-	-	-	-	-	-	-
Brown Bullhead	**6.72**	6.75	5.50	1.83	2.33	0.83	2.00	0.83	0.67	0.67	-	**2.14**	0.17	0.50	1.17	0.33	0.67	0.50	1.72	1.67
Channel Catfish	**0.37**	-	0.13	-	0.17	-	0.25	-	-	0.17	-	**0.07**	-	-	0.17	0.17	-	0.50	0.67	0.17
Burbot	**0.04**	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-	-	-	-	-
White Perch	**90.12**	22.00	36.38	59.83	130.50	79.50	196.75	119.00	127.50	123.17	92.00	**98.66**	91.83	138.00	144.17	17.17	35.67	76.75	141.44	73.64
White Bass	**0.08**	-	0.13	-	-	-	-	0.17	0.17	-	-	**0.05**	-	0.17	-	0.33	0.50	1.38	0.17	1.00
Rock Bass	**0.26**	-	-	-	-	0.17	-	-	-	-	-	**0.02**	-	-	0.17	-	0.83	-	0.17	-
Pumpkinseed	**3.97**	17.00	8.25	0.83	4.33	0.33	3.25	0.50	1.00	0.67	0.17	**3.63**	0.83	1.00	2.50	0.67	0.50	1.63	0.67	0.83
Bluegill	**0.57**	7.13	3.75	0.50	0.33	2.50	6.50	5.33	3.17	5.55	6.67	**4.14**	6.83	1.17	11.33	4.33	11.83	0.63	0.33	0.67
Smallmouth Bass	**1.11**	0.50	-	-	-	-	0.50	-	-	0.17	-	**0.12**	-	-	-	-	-	-	-	-
Largemouth Bass	**0.02**	-	-	-	-	-	0.25	-	-	-	0.17	**0.04**	-	-	-	-	-	-	-	-
Black Crappie	**0.11**	0.25	0.38	0.33	0.17	0.17	2.25	1.00	0.33	-	-	**0.49**	-	-	-	-	-	-	-	-
Yellow Perch	**138.65**	190.63	182.88	115.33	109.67	103.00	119.00	16.50	63.00	129.54	43.17	**107.27**	47.17	17.67	26.67	71.67	59.00	39.63	36.52	67.30
Walleye	**16.88**	4.50	7.63	6.50	8.00	5.83	10.75	5.33	9.17	8.00	10.83	**7.65**	6.33	5.17	17.17	6.33	5.33	7.25	9.27	6.17
Round Goby	**-**	-	-	0.33	0.33	0.50	-	-	-	-	-	**0.12**	-	-	-	-	-	-	-	-
Freshwater Drum	**15.50**	21.25	7.38	7.33	7.33	9.50	19.75	11.33	6.50	8.67	4.83	**10.39**	5.50	3.33	5.33	4.83	10.33	28.38	11.50	7.00
Total catch	**292**	277	270	199	273	249	371	164	223	286	173	**248**	254	189	227	112	137	171	221	173
Number of species	**14**	14	15	15	16	14	16	13	13	12	12	**14**	11	12	12	12	13	14	15	16
Number of sets		8	8	6	6	6	4	6	6	6	6		6	6	6	6	6	8	6	6

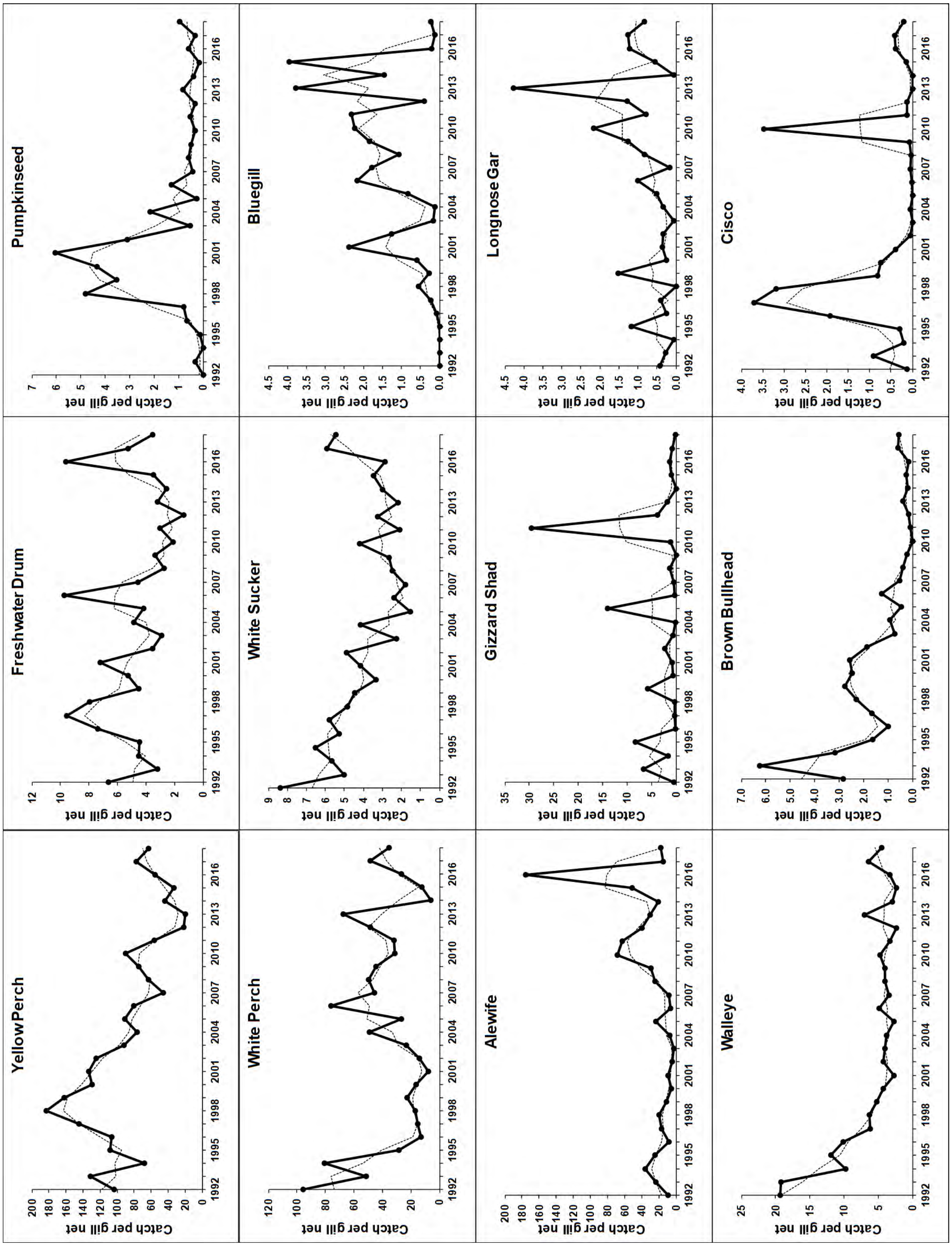


FIG. 1.1.4. Abundance trends (annual means) for the most common species caught in gill nets at three areas in the Bay of Quinte (Conway, Hay Bay and Big Bay; see Fig. 1.1.1). Dotted lines show 3-yr running averages (two years for first and last years graphed).

abundance declined from 1992-2000 but has remained very stable since. Freshwater Drum and Gizzard Shad catches show no remarkable trends. White Sucker abundance declined since 1992, gradually levelling off in recent years but spiked in 2017 and 2018. Brown Bullhead abundance has declined precipitously to low levels. Bluegill and Pumpkinseed abundance increased in the late-1990s then declined through 2004. Thereafter, Bluegill catches increased but Pumpkinseed catches did not until 2016 through 2018 when Bluegill abundance was low. Cisco catches increased in the late-1990s then declined; most recently Cisco catch increased in 2015, 2016 and again in 2017. Cisco catch declined slightly in 2018.

Bay of Quinte (additional gill netting in 2018; Table 1.1.24)

Three additional upper Bay of Quinte gill net sampling sites were netted in 2016, 2017 and 2018. The 2018 sampling included a seasonal component (June, July/August and October). Together, along with Big Bay and Hay Bay, this netting provided a more complete description of the upper and middle Bay of Quinte fish community (Table 1.1.24). Overall, the dominant species were Yellow Perch, White Perch, Alewife, Walleye, White Sucker, and Freshwater Drum. Alewife were abundant only in June.

Species Highlights

Lake Whitefish

Thirty-one Lake Whitefish were caught and interpreted for age in the 2018 index gill nets (Table 1.1.25). Fish ranged in age from 3-25 years. Thirteen year-classes were represented. Fourteen (45%) whitefish were from either the 2013 and 2014 year-classes.

Cisco

One hundred and sixteen Cisco were caught and interpreted for age in the 2018 index gill nets (Table 1.1.26). Fish ranged in age from 1-16 years. Fourteen year-classes were represented. Seventy-one (61%) Cisco were from the 2014 year-class.

Walleye

Five hundred and ninety-five Walleye were caught and interpreted for age in the 2018 summer index gill nets (Table 1.1.27). One hundred and fifty-four Walleye (26%) were age-3 (2015 year-class) and 123 (21%) were age-4 (2014 year-class). In the Kingston Basin nearshore gill nets, 92% (196) of the 212 Walleye were age-5 or greater.

TABLE 1.1.24. Species-specific catch per gill net set at **upper and middle Bay of Quinte** gill net site locations (**Trenton, Belleville, Big Bay, Deseronto and Hay Bay**) in June and August, 2018. The total catch and the number of species caught and gill nets set are indicated.

	Trenton			Belleville			Big Bay				Deseronto			Hay Bay				All sites
Species	Jun	Jul	Oct	Jun	Jul	Oct	Jun	Jul	Aug	Oct	Jun	Aug	Oct	Jun	Jul	Aug	Oct	
Lake Sturgeon	-	-	-	-	-	-	-	-	0.50	-	-	-	-	-	-	-	-	0.02
Longnose Gar	16.80	1.50	-	0.50	-	-	2.65	3.15	1.65	-	-	-	-	-	-	-	-	1.25
Bowfin	1.65	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.08
Alewife	33.54	-	-	10.91	-	-	3.80	-	-	-	55.72	-	-	131.62	8.26	-	-	18.27
Gizzard Shad	0.50	2.65	3.00	1.00	0.50	1.00	-	0.50	-	-	0.50	-	4.00	-	0.50	-	0.75	0.77
Brown Trout	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.25	0.02
Lake Whitefish	-	-	-	-	-	3.50	-	-	-	1.00	-	-	1.00	0.25	-	-	0.25	0.31
Cisco	-	-	1.00	-	-	0.50	-	-	-	3.50	0.50	-	3.50	1.75	-	-	1.50	0.74
Northern Pike	0.50	-	0.50	-	-	1.00	0.50	-	-	2.00	1.00	0.50	1.50	2.83	0.50	0.25	0.25	0.72
White Sucker	0.50	1.50	0.50	5.00	0.50	1.00	23.50	3.50	2.00	2.50	6.50	-	1.00	13.75	4.25	0.75	1.00	4.17
Silver Redhorse	-	-	0.50	-	-	-	0.50	-	-	-	-	-	-	-	-	-	-	0.05
River Redhorse	0.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.02
Golden Shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.25	-	-	0.02
Brown Bullhead	1.00	-	-	0.50	-	1.00	3.50	0.50	1.00	-	-	3.50	-	-	-	-	0.75	0.60
Channel Catfish	-	-	-	-	-	0.50	0.50	-	-	-	-	-	-	-	-	-	-	0.05
American Eel	-	-	-	-	-	-	-	-	-	-	1.65	-	-	-	-	-	-	0.08
Trout-perch	-	-	1.65	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.08
White Perch	34.48	87.78	6.30	58.22	13.76	1.50	95.41	94.28	31.22	3.65	53.80	144.00	3.50	1.50	84.22	-	37.34	41.62
White Bass	-	6.50	-	7.30	-	-	3.00	-	-	-	0.50	1.00	-	0.50	-	0.50	0.50	1.01
Rock Bass	2.65	-	-	-	-	-	-	-	-	-	-	0.50	0.50	-	-	-	0.50	0.22
Pumpkinseed	9.46	3.50	-	4.15	-	-	-	1.00	1.50	-	-	2.00	-	-	6.23	-	-	1.62
Bluegill	14.22	-	-	9.26	-	-	-	-	2.00	-	-	2.15	-	-	-	-	-	1.32
Yellow Perch	73.24	14.87	32.09	39.35	-	52.22	132.83	16.37	52.72	20.83	78.54	120.50	43.50	202.71	49.61	20.75	19.57	60.11
Walleye	10.00	6.00	5.50	4.00	1.00	24.15	14.50	3.00	1.00	13.00	65.00	7.00	7.50	4.40	3.50	0.75	65.38	14.75
Freshwater Drum	2.00	14.15	-	12.00	3.50	-	18.00	2.00	1.00	-	8.50	2.00	-	0.50	3.75	1.50	3.33	3.87
Total catch	201	138	51	152	19	86	299	124	95	46	272	283	66	360	161	25	131	152
Number of species	15	9	9	12	5	10	12	9	10	7	11	10	9	10	10	6	13	25
Number of net sets	2	2	2	2	2	2	2	2	2	2	2	2	2	4	4	4	4	42

TABLE 1.1.25. Age distribution of **31 Lake Whitefish** sampled from index gill nets, by region, during 2018. Also shown are mean fork length and mean weight.

	Age (years)/year-class													
	3	4	5	6	7	8	12	13	14	15	22	24	25	
Region	2015	2014	2013	2012	2011	2010	2006	2005	2004	2003	1996	1994	1993	Total
Northeast	1													1
Kingston Basin (nearshore)			1									1		2
Kingston Basin (deep)	1	2	2	1			1		2	2	1		1	13
Bay of Quinte		5	4		1	3	1	1						15
Total aged	2	7	7	1	1	3	2	1	2	2	1	1	1	31
Mean fork length (mm)	367	344	395	380	456	448	470	433	537	517	467	568	562	
Mean weight (g)	587	424	735	597	1071	1024	1226	853	1994	1606	2381	2336	2448	

TABLE 1.1.26. Age distribution of **116 Cisco** sampled from index gill nets, by region, 2018. Also shown are mean fork length and mean weight.

	Age (years)/year-class														
	1	2	3	4	5	6	7	8	9	10	11	12	14	16	
Region	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2004	2002	Total
Northeast	1	2		4	1	2			1	1		1			13
Kingston Basin (nearshore)	1			3	1		1	1	1	1					9
Kingston Basin (deep)		2	6	48	3			2					1	1	63
Bay of Quinte				16	6	2		1	1	1	3	1			31
Total aged	2	4	6	71	11	4	1	4	3	3	3	2	1	1	116
Mean fork length (mm)	196	245	302	323	328	367	375	403	386	385	366	425	373	410	
Mean weight (g)	91	180	296	423	438	666	591	854	812	715	643	1220	481	729	

TABLE 1.1.27. Age distribution of **595 Walleye** sampled from **summer** index gill nets, by region, 2018. Also shown are mean fork length, mean weight, mean GSI (females), and percent mature (females). GSI = gonadal somatic index calculated for females only as log10 (gonad weight + 1)/log10(weight). Note that a GSI greater than approximately 0.25 indicates a mature female.

	Age (years)/year-class																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	17	18	19	20	
Region	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2001	2000	1999	1998	Total
Western			1		2	3							1							7
Kingston Basin (nearshore)			9	7	3	8	29	11	8	29	19	5	23	14	25	9	1	10	2	212
Northeast			1	7	2	1	6	3	2	9	4	1	2	2	4					44
Bay of Quinte	14	46	143	109	4	1	4	2	1	5	1	1	1							332
Total aged	14	46	154	123	11	13	39	16	11	43	24	7	27	16	29	9	1	10	2	595
Mean fork length (mm)	236	334	413	463	535	580	575	601	591	618	636	635	647	644	654	638	724	634	652	
Mean weight (g)	133	399	821	1169	2009	2804	2572	3028	2762	3239	3493	3473	3652	3609	3742	3427	5328	3210	3923	
Mean GSI females	0.05	0.13	0.21	0.26	0.33	0.39	0.41	0.44	0.45	0.42	0.44	0.46	0.46	0.46	0.47	0.46		0.39	0.49	
Percent mature	0.00	0.00	0.28	0.72	0.80	1.00	1.00	1.00	1.00	1.00	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00		

1.2 Lake Ontario and Bay of Quinte Fish Community Index Trawling

J. A. Hoyle and E. Brown, Lake Ontario Management Unit

Bottom trawling has been used to monitor the relative abundance of small fish species and the young of large-bodied species in the fish community since the 1960s. After some initial experimentation with different trawl specifications, two trawl configurations (one for the Bay of Quinte and one for Lake Ontario) were routinely employed (see trawl specifications Table 1.2.1).

In the Kingston Basin of eastern Lake Ontario, six sites, ranging in depth from about 20 to 35 m, were visited about four times annually up until 1992 when three sites were dropped. From 1992 to 2015, three visits were made to each of three sites annually, and four replicate ½ mile trawls are made during each visit. After 1995, a deep water site was added outside the Kingston Basin, south of Rocky Point (visited twice annually with a trawling distance of 1 mile; about 100 m water depth), to give a total of four Lake sites (Fig. 1.2.1). In 2014, a second trawl site/ depth was added at Rocky Point (60 m) and two trawl sites at each of Cobourg and Port Credit (60 and 100 m depths at both locations). In 2015, the Lake Ontario trawling was expanded significantly to include several more sampling depths at each of Rocky Point, Cobourg, and Port Credit. In 2016 and 2017, the three Kingston Basin sites that were dropped in 1992, were added back in to the sampling design, and trawling was not done at Cobourg or Port Credit. [Note that these sites were sampled in spring and fall prey fish assessments (see Section 1.7 and 1.8)]. In the Bay of Quinte, six fixed-sites, ranging in depth from about 4 to 21 m, are visited annually on two or three occasions during mid to late-summer. Four replicate ¼ mile trawls are made during each visit to each site. The 2018 bottom trawl sampling design is shown in Table 1.2.2.

Twenty-eight species and nearly 85,000 fish were caught in 77 bottom trawls in 2018 (Jun 18 to Sep 5, Table 1.2.3). Alewife (25%). Round Goby (19%), Rainbow Smelt (14%), Yellow Perch (13%), Gizzard Shad (11%), White Perch (10%) collectively made up 92% of the catch by number. Species-specific catches in the 2018 trawling program are shown in Tables 1.2.4-1.2.16.

TABLE 1.2.1. Bottom trawl specifications used in Eastern Lake Ontario and Bay of Quinte Fish Community sampling.

	3/4 Western (Poly) (Bay Trawl)	3/4 Yankee Standard No. 35 (Lake Trawl)
Head Rope Length (m)	14.24	12
Foot Rope Length (m)	19	17.5
Side Brail Height (m)	2	1.9
Mesh Size (front)	4" knotted black poly	3.5" knotted green nylon
Twine Type (middle)	3" knotted black poly	2.5" knotted nylon
Before Codend	2" knotted black poly	2" knotted nylon
	1.5" knotted black nylon	(chafing gear)
	1" knotted black nylon	
Codend Mesh Size	0.5" knotted white nylon	0.5" knotless white nylon
Remarks:	Fishing height 2.0 m	Fishing height 1.9 m
	FISHNET gear dimensions	FISHNET gear dimensions
	as per Casselman 92/06/08	as per Casselman 92/06/08
GRLEN:length of net	N/A	N/A
GRHT:funnel opening height	2.25 m	2.3 m
GRWID:intake width	6.8 m	9.9 m
GRCOL:1 wt,2 bl,3 gn	2	7 (discoloured)
GRMAT:1 nylon,2 ploypr.	2	1
GRYARN:1 mono,2 multi	2	2
GRKNOT:1 knotless,2 knots	2	2

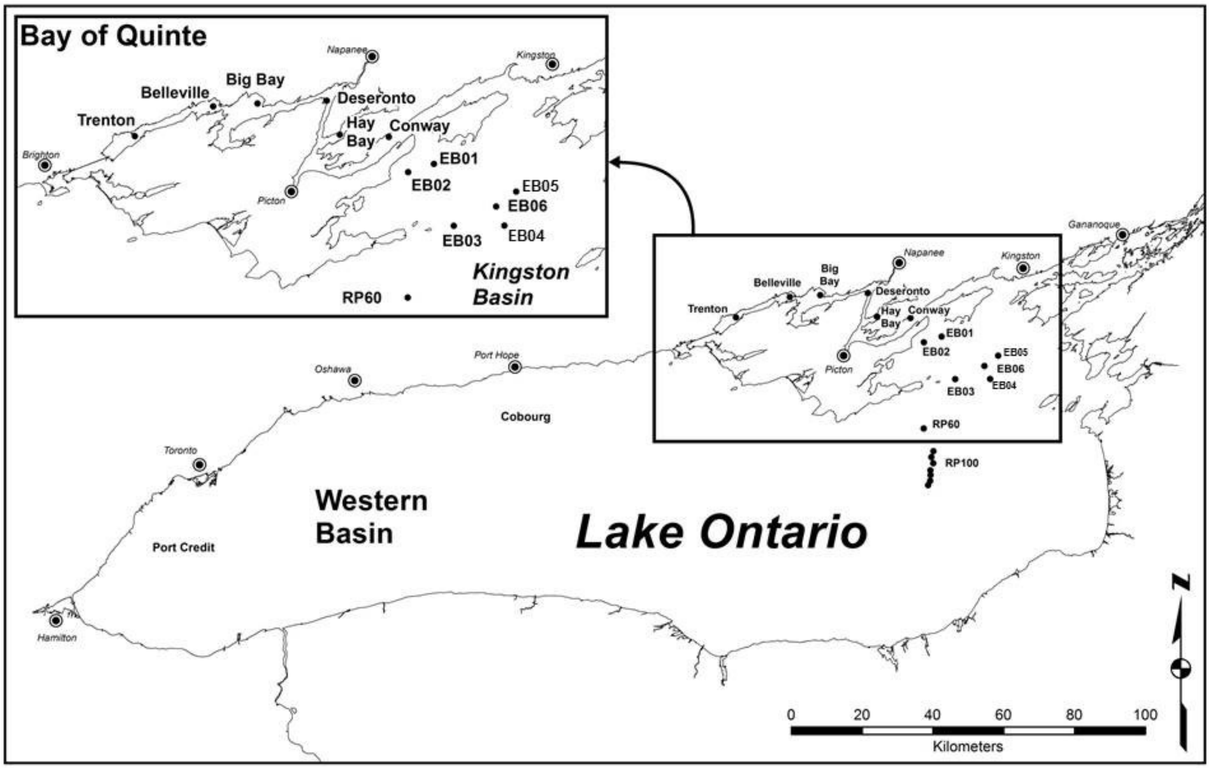


FIG. 1.2.1. Map of north eastern Lake Ontario. Shown are eastern Lake Ontario and Bay of Quinte fish community index bottom trawling site locations.

TABLE 1.2.2. Sampling design of the Lake Ontario fish community index bottom trawling program including geographic stratification, number of visits, number of replicate trawls made during each visit, and the time-frame for completion of visits. Also shown is the year in which bottom trawling at a particular area was initiated and the number of years that trawling has occurred. Note that in 2018 only three visits were made to EB03 and 4 replicate trawls were conducted during the third visit.

						Site location					
Region name	Area Name (Area code)	Site name	Depth (m)	Visits*	Replicates x duration	Latitude	Longitude	Visits x reps	Time-frame	Start year	Number years
Kingston Basin	Eastern Basin (EB)	EB01	30	3	1 x 5 minute	440400	764720	3	Jun 20-Sep 9	2016	3
Kingston Basin	Eastern Basin (EB)	EB02	30	3	1 x 5 minute	440280	765120	3	Jun 20-Sep 9	1972	47
Kingston Basin	Eastern Basin (EB)	EB03	21	3	1 x 5 minute	435780	764810	3	Jun 20-Sep 9	1972	47
Kingston Basin	Eastern Basin (EB)	EB03**	21	1	4 x 5 minute**	435780	764810	4	Aug 1-Sep 15	1972	47
Kingston Basin	Eastern Basin (EB)	EB04	35	3	1 x 5 minute	435680	763700	3	Jun 20-Sep 9	2016	3
Kingston Basin	Eastern Basin (EB)	EB05	33	3	1 x 5 minute	440110	763540	3	Jun 20-Sep 9	2016	3
Kingston Basin	Eastern Basin (EB)	EB06	35	3	1 x 5 minute	435940	763910	3	Jun 20-Sep 9	1972	47
Rocky Point	Rocky Point (RP)	0060	60	1	1 x 5 minute	434969	765105	1	July	2014	5
Rocky Point	Rocky Point (RP)	0080	80	1	1 x 5 minute	434627	764887	1	July	2015	4
Rocky Point	Rocky Point (RP)	0090	90	1	1 x 5 minute	434534	764929	1	July	2015	4
Rocky Point	Rocky Point (RP)	0100	100	1	1 x 5 minute	434442	764888	1	July	1997	22
Rocky Point	Rocky Point (RP)	0110	110	1	1 x 5 minute	434335	764942	1	July	2015	4
Rocky Point	Rocky Point (RP)	0120	120	1	1 x 5 minute	434261	764937	1	July	2015	4
Rocky Point	Rocky Point (RP)	0130	130	1	1 x 5 minute	434173	764942	1	July	2015	4
Rocky Point	Rocky Point (RP)	0140	140	1	1 x 5 minute	434105	764983	1	July	2015	4
Bay of Quinte	Conway (LB)	BQ17	21	2	4 x 6 minutes	440650	765420	8	Aug 1-Sep 15	1972	47
Bay of Quinte	Hay Bay (MB)	BQ15	5	2	4 x 6 minutes	440650	770175	8	Aug 1-Sep 15	1972	47
Bay of Quinte	Deseronto (UB)	BQ14	5	2	4 x 6 minutes	441000	770360	8	Aug 1-Sep 15	1972	47
Bay of Quinte	Big Bay (UB)	BQ13	5	2	4 x 6 minutes	440975	771360	8	Aug 1-Sep 15	1972	47
Bay of Quinte	Belleville (UB)	BQ12	5	2	4 x 6 minutes	440920	772010	8	Aug 1-Sep 15	1972	47
Bay of Quinte	Trenton (UB)	BQ11	4	2	4 x 6 minutes	440600	773120	8	Aug 1-Sep 15	1972	47

* Note that each **visit** represents a different **date**.

** This "special" visit to EB03 to conduct 4 trawls can be done on the third (last) "regular" visit to EB03

TABLE 1.2.3. Species-specific total bottom trawl catch in 2018 from Jun 18 to Sep 5. Frequency of occurrence (FO) is the number of trawls, out of a possible 77, in which each species (28 species and 84,917 individual fish) was caught.

Species	FO	Catch	Biomass (kg)	Mean weight (g)
Alewife	64	20,876	106.257	5.1
Gizzard Shad	33	9,110	80.021	8.8
Lake Trout	7	15	0.639	42.6
Lake Whitefish	7	19	0.291	15.3
Cisco (Lake Herring)	5	22	0.250	11.4
Rainbow Smelt	32	12,085	29.330	2.4
White Sucker	15	20	8.994	449.7
Common Carp	3	5	0.028	5.6
Spottail Shiner	39	1,756	5.424	3.1
Brown Bullhead	24	119	33.625	282.6
Channel Catfish	4	5	0.344	68.9
American Eel	5	8	0.852	106.4
Trout-perch	39	1,116	2.574	2.3
White Perch	40	8,732	92.982	10.6
White Bass	23	76	1.195	15.7
Morone sp.	1	138	0.046	0.3
Rock Bass	8	28	0.176	6.3
Pumpkinseed	22	223	7.294	32.7
Bluegill	17	188	1.384	7.4
Largemouth Bass	16	109	0.758	7.0
Lepomis sp.	26	801	0.274	0.3
Yellow Perch	48	11,170	67.305	6.0
Walleye	43	339	28.300	83.5
Johnny Darter	5	8	0.010	1.3
Logperch	11	128	0.279	2.2
Tessellated Darter	1	2	0.003	1.3
Round Goby	44	15,878	37.707	2.4
Freshwater Drum	37	1,054	110.519	104.9
Slimy Sculpin	4	5	0.047	9.5
Deepwater Sculpin	8	837	19.128	22.9
Unknown	2	44	0.012	0.3
Totals		84,917	636	7.5

Lake Ontario

Kingston Basin (Tables 1.2.4 and 1.2.5)

Bottom trawls were conducted at six sites from June to September 2018. Seven species were caught with the most abundant species being Round Goby, Rainbow Smelt and Alewife. Round Goby abundance increased through the summer; catches were lowest in June and highest in September. Alewife and Rainbow Smelt catches were highest in June and lowest in August. Trend through time catches for most common species are shown in Fig. 1.2.2.

TABLE 1.2.4. Species-specific catch per trawl at six sites (**EB01, EB02, EB03, EB04, EB05, EB06**) in the Kingston Basin of Lake Ontario, 2018. Catches are averages for the number of trawls indicated. The total number of fish and species caught and trawls conducted are indicated.

Species	Month: Jun	Aug	Sep	Total
Alewife	2195.37	9.24	24.63	640.44
Lake Trout	0.00	0.00	0.27	0.11
Lake Whitefish	0.00	0.00	0.80	0.34
Rainbow Smelt	3844.83	61.85	523.96	1340.75
White Perch	0.40	0.00	0.00	0.11
Yellow Perch	0.40	0.00	0.00	0.11
Round Goby	0.80	2142.85	2395.88	1639.28
Total catch	6042	2214	2946	3621
Number of species	5	3	5	7
Number of trawls	6	6	9	21

EB02 (Table 1.2.6).

Three species: Round Goby, Rainbow Smelt and Alewife were caught at EB02 in 2018. Threespine Stickleback, having risen to high levels of abundance in the late 1990s, declined rapidly after 2003 and was absent in the EB02 catches since 2007. Slimy Sculpin, another formerly abundant species has also been absent since 2007.

EB03 (Table 1.2.7)

Three species: Round Goby, Rainbow Smelt and Alewife were caught at EB03 in 2018. Round Goby, having first appeared in the EB03 catches in 2004, now generally dominate the total catch. Rainbow Smelt abundance was higher in the last four years especially 2018. As was the case for EB02, Threespine Stickleback have been absent from the EB03 catches since 2007.

EB06 (Table 1.2.8)

Three species: Round Goby, Rainbow Smelt and Alewife were caught at EB06 in 2018

Rocky Point (Tables 1.2.9 and 1.2.10)

Five species: Alewife, Deepwater Sculpin, Rainbow Smelt, Slimy Sculpin, and Lake Trout were caught at Rocky Point in 2018. Alewife were most common at 60 and 80 m sites. Deepwater Sculpin were most common at deepest water depths.

TABLE 1.2.5. Species-specific catch per trawl at six sites (**EB01, EB02, EB03, EB04, EB05, EB06**) by month in the Kingston Basin of Lake Ontario, 2018. Catches are averages for 1 to 4 trawls during each of 3 or 4 visits during summer. The total number of fish and species caught and trawls conducted are indicated.

	EB01			EB02			EB03			EB04			EB05			EB06			
Species	Jun	Aug	Sep	Jun	Aug	Sep	Jun	Aug	Sep	Jun	Aug	Sep	Jun	Aug	Sep	Jun	Aug	Sep	Total
Alewife	0.000	0.000	0.000	7.229	43.373	81.928	0.000	2.410	22.892	631.325	2.410	0.000	12531.2	7.229	48.193	2.410	0.000	0.000	743.4
Lake Trout	0.000	0.000	2.410	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.1
Lake Whitefish	0.000	0.000	7.229	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.4
Rainbow Smelt	38.554	2.410	9.639	55.422	4.819	118.072	22941.3	245.783	1063.85	28.916	0.000	38.554	0.000	93.976	284.337	4.819	24.096	9.639	1386.9
White Perch	2.410	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.1
Yellow Perch	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.410	0.000	0.000	0.000	0.000	0.000	0.1
Round Goby	2.410	1605.71	540.904	2.410	1731.16	1114.537	0.000	9190.10	4617.94	0.000	0.000	535.193	0.000	330.120	243.373	0.000	0.000	657.152	1142.8
Total catch	43	1608	560	65	1779	1315	22941	9438	5705	660	2	574	12534	431	576	7	24	667	3274
Number of species	3	2	4	3	3	3	1	3	3	2	1	2	2	3	3	2	1	2	7
Number of trawls	1	1	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	21

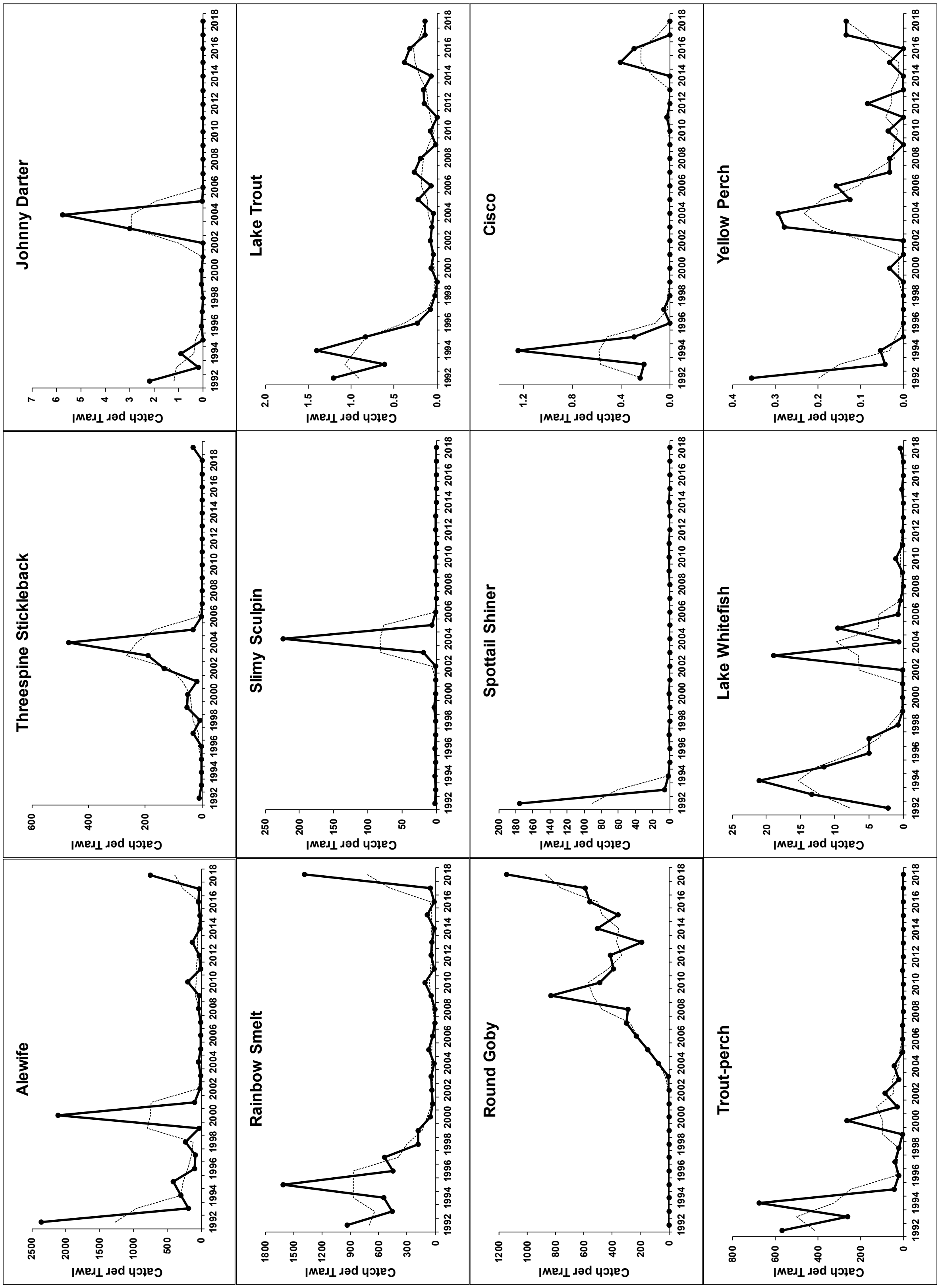


FIG. 1.2.2. Abundance trends (annual means) for the most common species caught in bottom trawls at three to six sites in the Kingston Basin, eastern Lake Ontario (EB01, EB02, EB03, EB04, EB05, EB06); see Fig. 1.2.1). Dotted lines show 3-yr running averages (two years for first and last years graphed).

TABLE 1.2.6. Species-specific catch per trawl (12 min duration; 1/2 mile) by year in the fish community index bottom trawling program during summer at **EB02**, Kingston Basin, Lake Ontario. Catches are the mean number of fish observed for the number of trawls indicated. Total catch and number of species caught are indicated.

	Year																			
Species	**1992-2000 mean**	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	**2001-2010 mean**	2011	2012	2013	2014	2015	2016	2017	2018
Alewife	**1220.379**	203.397	20.917	19.500	27.100	0.000	0.417	11.000	0.667	72.429	464.097	**81.952**	1.667	24.291	288.143	2.667	44.417	110.093	68.273	44.177
Rainbow Trout	**0.019**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Lake Trout	**0.202**	0.000	0.083	0.083	0.000	0.583	0.167	0.583	0.500	0.000	0.167	**0.217**	0.000	0.333	0.333	0.167	0.750	1.000	0.000	0.000
Lake Whitefish	**3.203**	0.167	0.000	0.583	0.400	0.250	0.000	0.167	0.000	0.250	0.000	**0.182**	0.000	0.083	0.000	0.000	0.000	0.000	0.000	0.000
Cisco	**0.362**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.083	0.000	0.000	0.000
Coregonus sp.	**0.006**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Rainbow Smelt	**440.950**	29.667	7.917	0.917	5.000	19.750	28.750	3.583	5.667	114.416	14.667	**23.033**	1.083	10.333	3.917	8.833	2.917	1.667	0.803	59.438
Emerald Shiner	**0.009**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Burbot	**0.009**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Threespine Stickleback	**13.395**	18.750	34.417	49.500	6.200	9.000	0.167	0.000	0.000	0.000	0.000	**11.803**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Trout-perch	**4.675**	0.250	0.000	0.167	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.042**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Yellow Perch	**0.019**	0.000	0.000	0.000	0.700	0.333	0.083	0.000	0.000	0.000	0.083	**0.120**	0.000	0.167	0.000	0.000	0.000	0.000	0.803	0.000
Walleye	**0.056**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.083	**0.008**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Johnny Darter	**0.077**	0.000	0.000	0.000	0.400	0.000	0.000	0.000	0.000	0.000	0.000	**0.040**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Round Goby	**0.000**	0.000	0.000	0.083	250.100	24.833	40.083	119.750	26.667	169.907	143.933	**77.536**	8.083	77.144	28.500	31.083	76.313	163.026	133.333	949.369
Sculpin sp.	**0.046**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Slimy Sculpin	**2.084**	0.417	0.667	44.083	74.900	0.750	0.167	0.000	0.000	0.000	0.000	**12.098**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Deepwater Sculpin	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.667	0.000	0.000	0.000
Total catch	**1685**	253	64	115	365	56	70	135	34	357	623	**207**	11	112	321	43	125	276	203	1053
Number of species	**9**	6	5	8	8	7	7	5	4	4	6	**6**	3	6	4	4	6	4	4	3
Number of trawls		12	12	12	10	12	12	12	12	12	12		12	12	12	12	12	3	3	3

TABLE 1.2.7. Species-specific catch per trawl (12 min duration; 1/2 mile) by year in the fish community index bottom trawling program during summer at **EB03**, Kingston Basin, Lake Ontario. Catches are the mean number of fish observed for the number of trawls indicated. Total catch and number of species caught are indicated.

	Year																			
	1992-2000											**2001-2010**								
Species	**mean**	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	**mean**	2011	2012	2013	2014	2015	2016	2017	2018
Alewife	**704.463**	57.375	21.375	8.000	168.385	14.833	15.250	33.917	156.339	0.000	0.250	**47.572**	0.125	33.292	75.500	43.125	1.875	13.857	30.522	15.663
Gizzard Shad	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.000	0.000	0.000	**0.025**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Chinook Salmon	**0.014**	0.000	0.000	0.000	0.000	0.667	0.000	0.000	0.000	0.000	0.000	**0.067**	0.000	0.000	0.000	0.000	0.125	0.000	0.000	0.000
Lake Trout	**0.847**	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.000	0.083	0.000	**0.033**	0.000	0.000	0.125	0.000	0.000	0.000	0.000	0.000
Lake Whitefish	**14.412**	0.000	0.000	43.938	2.333	50.000	3.000	1.417	0.000	0.083	4.667	**10.544**	0.125	0.000	0.000	0.000	0.375	0.000	0.000	0.000
Cisco	**0.292**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.125	0.000	0.000	0.000	1.500	1.000	0.000	0.000
Rainbow Smelt	**517.419**	20.000	207.511	109.245	1.917	25.667	20.625	21.500	0.250	11.583	217.947	**63.624**	30.750	3.250	111.500	20.625	343.832	135.829	185.808	4573.742
White Sucker	**0.093**	0.000	0.000	0.000	0.000	0.000	0.000	0.083	0.000	0.000	0.000	**0.008**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Common Carp	**0.130**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Spottail Shiner	**42.456**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.083	**0.033**	0.375	0.000	0.000	0.125	0.000	0.000	0.000	0.000
American Eel	**0.056**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Brook Stickleback	**0.009**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Threespine Stickleback	**32.894**	67.375	680.287	459.421	2781.754	116.083	8.500	0.000	0.000	0.000	0.000	**411.342**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Trout-perch	**689.171**	175.000	592.212	56.298	255.161	3.417	3.750	0.417	0.000	0.000	0.000	**108.625**	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000
White Perch	**0.032**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pumpkinseed	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.083	**0.008**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Smallmouth Bass	**0.014**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Largemouth Bass	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.083	**0.008**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Yellow Perch	**0.093**	0.000	0.000	0.625	0.083	0.000	0.500	0.167	0.125	0.000	0.000	**0.150**	0.000	0.000	0.000	0.000	0.125	0.000	0.000	0.000
Walleye	**0.236**	0.000	0.000	0.063	0.000	0.000	0.125	0.000	0.000	0.417	0.000	**0.060**	0.250	0.250	0.000	0.000	0.000	0.286	0.000	0.000
Johnny Darter	**0.875**	0.000	0.000	9.875	32.833	0.167	0.000	0.000	0.000	0.000	0.000	**4.288**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Round Goby	**0.000**	0.000	0.000	0.000	0.333	732.449	850.448	910.409	1100.409	2552.195	1079.944	**722.619**	2322.465	960.945	410.800	1968.925	1309.488	157.097	2300.515	4610.311
Freshwater Drum	**0.046**	0.000	0.000	0.000	0.083	0.000	0.125	0.000	0.125	0.000	0.000	**0.033**	0.000	0.250	0.000	0.000	0.500	0.143	0.000	0.000
Sculpin sp.	**0.194**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mottled Sculpin	**0.000**	0.000	0.000	0.688	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.069**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Slimy Sculpin	**0.370**	0.000	0.250	6.750	10.833	0.083	0.000	0.000	0.000	0.000	0.000	**1.792**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total catch	**2004**	320	1502	695	3254	943	902	968	1257	2565	1303	**1371**	2354	998	598	2033	1658	308	2517	9200
Number of species	**10**	4	5	10	10	9	9	9	5	6	7	**7**	8	5	4	4	8	6	3	3
Number of trawls		8	8	16	12	12	8	12	8	12	12		8	7	8	8	8	7	6	6

TABLE 1.2.8. Species-specific catch per trawl (12 min duration; 1/2 mile) by year in the fish community index bottom trawling program during summer at **EB06**, Kingston Basin, Lake Ontario. Catches are the mean number of fish observed for the number of trawls indicated. Total catch and number of species caught are indicated.

	Year																			
Species	**1992-2000 mean**	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	**2001-2010 mean**	2011	2012	2013	2014	2015	2016	2017	2018
Alewife	**85.631**	5.583	0.250	0.083	1.250	0.417	8.000	0.917	0.667	10.833	1.083	**2.908**	0.667	0.625	0.583	0.000	0.000	1.333	0.803	0.803
Lake Trout	**0.611**	0.083	0.083	0.083	0.083	0.000	0.000	0.000	0.000	0.000	0.000	**0.033**	0.000	0.125	0.000	0.000	0.250	0.000	0.000	0.000
Lake Whitefish	**4.546**	0.000	0.167	0.167	0.250	0.000	0.000	0.083	0.000	0.000	0.083	**0.075**	0.000	0.000	0.000	0.000	0.083	0.000	0.000	0.000
Cisco	**0.028**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Rainbow Smelt	**743.701**	21.417	6.750	0.250	25.083	142.583	23.917	0.583	1.000	3.500	73.167	**29.825**	18.917	112.933	8.750	0.333	0.000	1.333	0.000	12.851
Threespine Stickleback	**7.722**	2.583	47.750	11.417	7.500	13.917	1.083	0.000	0.000	0.000	0.000	**8.425**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Trout-perch	**0.991**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Yellow Perch	**0.019**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Johnny Darter	**0.000**	0.000	0.000	0.000	0.333	0.000	0.000	0.000	0.000	0.000	0.000	**0.033**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Round Goby	**0.000**	0.000	0.000	0.000	0.000	0.000	5.000	82.934	1.667	8.667	877.914	**97.618**	1.917	200.416	208.949	0.333	0.083	453.048	19.277	219.051
Sculpin sp.	**0.009**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.803	0.000
Slimy Sculpin	**0.083**	0.083	0.000	3.583	399.183	15.750	0.250	0.000	0.000	0.500	1.500	**42.085**	0.000	0.125	0.167	0.000	0.000	0.000	0.000	0.000
Deepwater Sculpin	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.083	0.167	**0.025**	0.000	0.000	0.000	0.000	2.000	0.000	0.000	0.000
Total catch	**843**	30	55	16	434	173	38	85	3	24	954	**181**	22	314	218	1	2	456	21	233
Number of species	**6**	5	5	6	7	4	5	4	3	5	6	**5**	3	5	4	2	4	3	3	3
Number of trawls		12	12	12	12	12	12	12	12	12	12		12	8	12	12	12	3	3	3

Bay of Quinte

Conway (Table 1.2.11)

Nine species were caught at Conway in 2018. The most abundant species were Round Goby, Rainbow Smelt, Alewife and Yellow Perch.

Hay Bay (Table 1.2.12)

Sixteen species were caught at Hay Bay in 2018. The most abundant species were Alewife, White Perch and Yellow Perch.

Deseronto (Table 1.2.13)

Nineteen species were caught at Deseronto in 2018. The most abundant species were Alewife, Yellow perch and White Perch.

Big Bay (Table 1.2.14)

Seventeen species were caught at Big Bay in 2018. The most abundant species were White Perch, Sunfish, Alewife, Trout-perch, Yellow Perch and Freshwater Drum.

Belleville (Table 1.2.15)

Seventeen species were caught at Belleville in 2018. Gizzard Shad, Yellow Perch, White Perch, Trout-perch, Alewife and Freshwater Drum were the most abundant species in the catch.

Trenton (Table 1.2.16)

Nineteen species were caught at Trenton in 2018. The most abundant species were Yellow Perch, White Perch, Alewife, Gizzard Shad and Spottail Shiner.

Species Trends (Fig. 1.2.3).

Bottom trawl results were summarized across the six Bay of Quinte sites and presented graphically to illustrate abundance trends for major species in Fig. 1.2.3. All species show significant abundance changes over the long-term. The most abundant species remain White Perch, Yellow Perch, Alewife and Gizzard Shad. White Perch abundance declined significantly in 2014, remained low in 2015, increased in 2016 and 2017, and declined in 2018. Yellow Perch remain abundant but did decline in 2017 reflecting a poor year-class that year. Yellow Perch abundance increased in 2018. Alewife abundance remains high. Most centrarchid species are currently at moderate to high levels of abundance, although Pumpkinseed and Largemouth Bass catches were low in 2018. Other species currently at relatively high abundance levels include Gizzard Shad, Trout-perch, Spottail Shiner, Round Goby and Walleye. Species currently at low abundance levels relative to past levels include Brown Bullhead, Rainbow Smelt, White Sucker, Lake Whitefish and Johnny Darter.

TABLE 1.2.9. Species-specific catch per trawl (adjusted to 12 min duration; 1/2 mile) in the fish community index bottom trawling program during summer at **Rocky Point** (multiple water depths), Lake Ontario, 2018. Catches are the mean number of fish observed for the number of trawls indicated. Total catch and number of species caught are indicated.

	Site depth (m)							
Species	60	80	90	100	110	120	130	140
Alewife	682	1644	101	48	60	77	41	51
Lake Trout	0	0	2	0	0	0	0	0
Rainbow Smelt	12	31	12	5	0	0	0	0
Slimy Sculpin	0	0	5	0	2	2	2	0
Deepwater Sculpin	5	7	31	84	99	255	576	959
Total catch	699	1683	152	137	161	335	620	1009
Number of species	3	3	5	3	3	3	3	2
Number of trawls	1	1	1	1	1	1	1	1

Species Highlights

Catches of age-0 fish in 2018 for selected species and locations are shown in Tables 1.2.17-1.2.21 for Lake Whitefish, Cisco, Yellow Perch and Walleye.

Age-0 Lake Whitefish were caught at Conway but not Timber Island in 2018 (Table 1.2.17). Except for the 2003 and 2005 year-classes, age-0 Lake Whitefish catches have been low since the late 1990s.

Age-0 Cisco catches at Conway in 2018 were moderate relative to recent years (Table 1.2.18).

Age-0 catches of Yellow Perch were high in 2018 (Table 1.2.19). Four of the last five year-classes were high.

Following two exceptionally strong year-classes in 2014 and 2015, the age-0 Walleye catch

TABLE 1.2.10. Species-specific catch per trawl (adjusted to 12 min duration; 1/2 mile) by year in the fish community index bottom trawling program during summer at **Rocky Point, 100 m depth only**), eastern Lake Ontario. Catches are the mean number of fish observed for the number of trawls indicated. Total catch and number of species caught are indicated. No sampling in 2006, 2010.

	Year																			
Species	**1997-2000 mean**	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	**2001-2010 mean**	2011	2012	2013	2014	2015	2016	2017	2018
Alewife	**2.063**	2.750	0.375	1.500	5.750	0.125		6.875	1.500	0.375		**2.406**	0.500	0.000	84.500	13.000	114.500	0.000	4.819	48.193
Lake Trout	**0.063**	0.500	0.000	0.000	0.125	0.000		0.000	0.125	0.000		**0.094**	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Lake Whitefish	**0.094**	0.000	0.125	0.000	0.000	0.000		0.000	0.000	0.000		**0.016**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Rainbow Smelt	**200.500**	90.625	37.625	4.125	11.375	5.500		2.250	7.250	6.750		**20.688**	5.500	5.500	11.500	3.333	2.000	3.000	0.000	4.819
Threespine Stickleback	**0.000**	0.000	0.000	0.000	0.125	0.125		0.000	0.000	0.000		**0.031**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Rock Bass	**0.000**	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000		**0.000**	0.000	0.000	0.000	0.167	0.000	0.000	0.000	0.000
Round Goby	**0.000**	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000		**0.000**	0.000	0.000	0.000	0.167	0.000	0.000	0.000	0.000
Slimy Sculpin	**5.625**	1.250	0.125	2.250	95.750	14.250		24.750	8.875	5.000		**19.031**	2.250	0.000	12.000	8.000	7.500	5.000	12.048	0.000
Deepwater Sculpin	**0.000**	0.000	0.000	0.000	0.000	0.125		0.750	0.250	0.125		**0.156**	7.500	1.500	6.000	3.833	105.000	256.000	260.241	84.337
Total catch	**208**	95	38	8	113	20		35	18	12		**42**	16	7	114	29	229	264	277	137
Number of species	**3**	4	4	3	5	5		4	5	4		**4**	5	2	4	6	4	3	2	0
Number of trawls		4	4	4	4	4	0	4	4	4	0		4	1	2	6	4	1	1	1

TABLE 1.2.11. Species-specific catch per trawl (6 min duration; 1/4 mile) by year in the fish community index bottom trawling program at **Conway** (24 m depth), Bay of Quinte. Catches are the mean number of fish observed at each site for the number of trawls indicated. Total catch and number of species caught are indicated.

	Year																		
Species	**1992-2000 mean**	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	**2001-2010 mean**	2011	2012	2013	2014	2015	2016	2017	2018
Silver Lamprey	**0.000**	0.000	0.000	0.000	0.083	0.000	0.000	0.000	0.000	0.000	0.000	**0.008**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Alewife	**121.972**	0.000	0.000	2.250	1.917	0.417	9.667	0.083	214.622	1.583	0.333	**23.087**	375.352	0.125	14.875	97.809	11.750	85.332	4.625	4.875
Gizzard Shad	**0.000**	0.000	0.000	0.000	0.000	0.000	1.167	0.000	0.000	0.000	0.000	**0.117**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Chinook Salmon	**0.028**	0.000	0.000	0.000	0.000	0.167	0.083	0.000	0.000	0.000	0.000	**0.025**	0.000	0.000	0.000	0.125	0.000	0.000	0.000	0.000
Brown Trout	**0.000**	0.000	0.125	0.167	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.029**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Lake Trout	**0.014**	0.000	0.250	0.000	0.417	0.000	0.000	0.000	0.000	0.000	0.000	**0.067**	0.000	0.125	0.375	0.000	0.250	0.000	0.000	1.625
Lake Whitefish	**13.208**	1.000	1.000	8.083	0.750	3.083	3.833	4.750	0.250	0.333	0.333	**2.342**	0.625	0.000	7.000	2.250	0.125	0.000	2.375	2.000
Cisco	**2.301**	0.000	0.250	3.000	0.083	7.667	4.500	2.000	0.167	0.000	6.333	**2.400**	8.250	23.500	1.625	11.750	1.750	3.375	1.250	2.750
Coregonus sp.	**0.000**	0.000	0.000	0.083	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.008**	0.000	0.000	0.000	0.000	0.000	0.000	0.125	0.000
Rainbow Smelt	**112.713**	0.000	39.625	10.167	3.583	6.750	0.083	25.167	1.083	0.083	0.000	**8.654**	0.625	0.500	8.750	29.875	7.000	0.500	12.000	46.750
White Sucker	**4.412**	134.836	28.750	6.667	7.417	4.750	3.167	11.250	0.500	0.000	0.167	**19.750**	0.500	1.375	1.375	0.000	0.875	1.250	1.250	0.000
Moxostoma sp.	**0.000**	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.013**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Spottail Shiner	**0.000**	0.625	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.063**	0.000	0.000	0.000	0.000	0.125	0.000	0.000	0.000
American Eel	**0.056**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.125	0.000
Burbot	**0.000**	0.000	0.000	0.000	0.083	0.000	0.000	0.000	0.000	0.000	0.000	**0.008**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Threespine Stickleback	**0.019**	0.000	0.000	0.083	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.008**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Trout-perch	**132.813**	139.443	58.234	53.667	43.333	12.250	0.500	1.000	13.000	0.083	0.000	**32.151**	0.500	0.000	1.125	38.875	2.750	0.500	10.125	0.375
White Perch	**0.116**	0.000	0.000	0.000	0.000	0.000	3.000	0.000	0.000	0.250	0.167	**0.342**	5.500	0.250	0.375	0.000	0.000	0.125	0.125	0.000
White Bass	**0.000**	0.000	0.000	0.000	0.000	0.000	0.833	0.000	0.000	0.000	0.000	**0.083**	1.125	0.000	0.000	0.000	0.000	0.125	0.000	0.000
Rock Bass	**0.028**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Bluegill	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.125	0.000	0.000	0.000	0.000	0.000	0.000
Yellow Perch	**12.597**	134.715	181.251	178.153	58.667	53.750	146.584	20.000	108.980	8.250	56.956	**94.731**	125.915	70.580	59.875	47.000	22.375	34.000	15.000	4.625
Walleye	**2.764**	1.250	0.000	0.250	1.000	0.083	0.417	0.417	0.083	0.000	0.333	**0.383**	0.375	0.000	0.000	0.125	0.125	0.375	0.250	0.625
Johnny Darter	**0.306**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Round Goby	**0.000**	0.000	0.500	282.241	79.167	127.225	40.833	173.211	89.723	80.768	146.979	**102.065**	261.710	203.978	103.471	81.375	175.493	247.749	149.175	176.274
Freshwater Drum	**0.000**	0.125	0.000	0.250	0.000	0.083	0.500	0.000	0.083	0.000	0.000	**0.104**	0.000	0.000	0.000	0.000	0.000	0.000	0.375	0.000
Sculpin sp.	**0.009**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mottled Sculpin	**0.009**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Slimy Sculpin	**0.079**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total catch	**403**	412	310	545	197	216	215	238	428	91	212	**286**	780	301	199	309	223	373	197	240
Number of species	**9**	7	9	12	12	11	14	9	10	7	8	**10**	11	9	10	9	11	10	12	9
Number of trawls		8	8	12	12	12	12	12	12	12	12		8	8	8	8	8	8	8	8

TABLE 1.2.12. Species-specific catch per trawl (6 min duration; 1/4 mile) by year in the fish community index bottom trawling program at **Hay Bay** (7 m depth), Bay of Quinte. Catches are the mean number of fish observed for the number of trawls indicated. Total catch and number of species caught are indicated.

	Year																		
Species	**1992-2000 mean**	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	**2001-2010 mean**	2011	2012	2013	2014	2015	2016	2017	2018
Alewife	**204.149**	566.143	21.125	1.750	67.067	72.097	394.507	695.331	631.710	713.136	967.999	**413.086**	561.676	530.946	360.990	498.796	411.086	1364.539	321.008	1325.918
Gizzard Shad	**10.153**	2.625	0.125	0.000	0.125	0.000	0.375	0.125	7.000	0.750	4.000	**1.513**	1.375	100.159	3.250	0.000	24.875	117.900	3.125	5.000
Lake Whitefish	**0.019**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cisco	**0.056**	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.100**	0.000	0.000	0.000	0.125	0.000	0.000	0.000	0.000
Rainbow Smelt	**3.958**	0.000	0.000	0.000	0.000	0.000	0.125	0.000	0.375	0.000	0.000	**0.050**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Northern Pike	**0.069**	0.000	0.000	0.125	0.000	0.000	0.000	0.125	0.000	0.125	0.000	**0.038**	0.000	0.000	0.000	0.250	0.000	0.000	0.000	0.000
White Sucker	**3.579**	3.500	0.125	5.875	8.250	0.000	0.625	4.875	3.000	0.000	3.625	**2.988**	4.375	2.125	3.625	3.250	2.125	0.000	1.875	0.625
Common Carp	**0.343**	0.250	0.000	0.000	0.000	0.875	0.000	0.000	0.750	0.125	0.000	**0.200**	0.000	0.125	0.000	0.000	0.000	0.000	0.125	0.000
Golden Shiner	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.125	0.000	**0.013**	0.000	0.375	0.125	0.000	0.125	6.000	0.000	0.000
Common Shiner	**0.000**	0.000	0.000	0.000	0.000	0.000	0.125	0.000	0.000	0.000	0.000	**0.013**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fathead Minnow	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.125	0.000	0.000	0.000	0.000	0.000
Brown Bullhead	**15.046**	32.750	15.750	8.000	10.375	10.500	15.000	8.875	0.750	3.500	2.500	**10.800**	0.250	1.750	5.375	2.125	1.500	0.750	2.625	0.125
Channel Catfish	**0.028**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.125	0.000	0.125	0.000	0.000	0.000	0.000	0.000
American Eel	**1.579**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Burbot	**0.023**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Trout-perch	**65.125**	5.750	2.750	3.750	77.500	1.750	3.000	59.500	6.625	3.750	4.375	**16.875**	22.875	1.125	6.250	4.625	25.375	0.250	1.250	3.375
White Perch	**94.666**	9.250	132.573	14.750	495.340	24.625	504.187	27.500	163.757	167.704	54.875	**159.456**	73.281	57.750	271.752	0.875	7.250	27.500	215.836	117.847
White Bass	**0.185**	0.000	0.000	1.750	0.125	0.125	1.375	1.375	0.875	0.500	2.000	**0.813**	9.500	0.250	0.000	0.125	1.625	9.750	0.125	2.750
Sunfish	**0.056**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Rock Bass	**0.028**	0.000	0.000	0.000	0.125	0.000	0.000	0.000	0.000	0.000	0.125	**0.025**	0.000	0.125	0.000	0.000	0.000	0.000	0.000	0.000
Pumpkinseed	**10.231**	19.625	11.875	0.750	4.625	1.125	44.500	11.375	8.625	0.250	13.250	**11.600**	0.875	2.500	4.000	2.750	0.875	4.625	10.500	0.250
Bluegill	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.125	3.625	0.125	0.250	**0.413**	0.125	0.375	0.125	0.000	0.000	0.000	0.375	0.125
Smallmouth Bass	**0.000**	0.000	1.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.125**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Largemouth Bass	**0.000**	0.250	1.750	0.000	0.000	0.000	0.000	0.000	0.375	1.375	2.125	**0.588**	1.000	1.250	0.125	0.000	0.000	0.000	0.000	0.375
Black Crappie	**0.000**	0.000	0.000	0.000	0.000	1.375	0.875	0.000	0.000	0.000	0.000	**0.225**	0.500	0.000	0.125	0.000	12.625	2.000	0.125	0.000
Lepomis sp.	**0.000**	0.000	0.000	0.000	0.000	13.375	0.000	0.000	0.000	0.000	0.000	**1.338**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.500
Yellow Perch	**372.617**	726.620	856.879	119.203	551.884	278.670	580.861	906.704	138.067	146.065	206.695	**451.165**	14.125	61.500	96.130	274.987	212.839	117.355	63.244	71.625
Walleye	**7.333**	7.125	3.250	1.750	3.125	4.125	7.125	8.500	13.375	5.000	8.500	**6.188**	7.750	3.375	3.250	7.000	10.500	2.500	8.625	3.125
Johnny Darter	**0.079**	0.000	1.750	0.000	0.000	0.000	0.000	0.125	0.000	0.000	0.000	**0.188**	0.000	0.000	0.000	0.125	0.000	0.000	0.000	0.000
Logperch	**0.046**	0.250	0.000	0.000	0.125	0.375	0.250	1.250	0.250	0.250	0.125	**0.288**	0.000	0.000	0.000	0.000	0.250	0.000	0.000	0.250
Brook Silverside	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.875	**0.088**	0.000	0.375	0.125	0.000	0.000	0.000	0.000	0.000
Round Goby	**0.000**	0.125	1.250	14.250	3.500	40.125	6.000	17.125	11.375	1.625	2.375	**9.775**	0.125	3.500	0.875	2.125	7.375	0.000	0.250	0.250
Freshwater Drum	**2.773**	4.375	4.875	6.875	10.500	16.375	39.125	6.000	5.000	5.125	11.125	**10.938**	8.250	6.250	11.875	2.375	3.250	5.375	30.125	5.125
Slimy Sculpin	**0.009**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total catch	**792**	1380	1055	179	1233	466	1598	1749	996	1050	1285	**1099**	706	774	768	800	722	1659	659	1537
Number of species	**15**	16	15	13	15	14	17	17	18	18	18	**16**	17	19	19	15	16	13	16	16
Number of trawls		8	8	8	8	8	8	8	8	8	8		8	8	8	8	8	8	8	8

TABLE 1.2.13. Species-specific catch per trawl (6 min duration; 1/4 mile) by year in the fish community index bottom trawling program at **Deseronto** (5 m depth), Bay of Quinte. Catches are the mean number of fish observed for the number of trawls indicated. Total catch and number of species caught are indicated.

	Year																		
Species	**1992-2000 mean**	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	**2001-2010 mean**	2011	2012	2013	2014	2015	2016	2017	2018
Longnose Gar	**0.014**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Alewife	**120.590**	180.074	47.625	277.403	55.380	54.219	106.270	1037.631	217.123	16.250	447.062	**243.903**	1017.115	332.364	1099.888	511.081	141.988	701.081	805.217	149.680
Gizzard Shad	**54.324**	32.000	20.875	11.875	1.375	22.000	62.100	29.250	109.387	47.539	20.500	**35.690**	53.000	453.242	67.765	0.125	73.125	304.873	6.000	29.375
Rainbow Smelt	**0.028**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Northern Pike	**0.028**	0.000	0.000	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.013**	0.000	0.000	0.000	0.000	0.125	0.000	0.000	0.000
White Sucker	**1.028**	0.625	0.375	1.250	1.250	0.125	0.375	0.375	0.625	2.625	0.125	**0.775**	1.375	0.375	4.875	4.000	1.750	0.375	4.375	0.500
Lake Chub	**0.000**	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.013**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Common Carp	**0.278**	0.000	0.000	0.000	0.000	0.125	0.000	0.000	0.000	0.000	0.125	**0.025**	0.375	0.000	0.000	0.000	0.000	0.000	0.000	0.250
Emerald Shiner	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	1.125	0.000	0.000	0.000	0.000	0.000	0.000
Spottail Shiner	**29.194**	25.250	25.000	35.625	1.500	18.875	54.750	28.750	104.125	38.625	18.000	**35.050**	40.250	25.625	29.250	126.375	69.500	124.064	47.750	21.125
Brown Bullhead	**24.250**	69.250	10.625	21.500	37.000	12.500	11.625	18.125	2.500	4.000	1.000	**18.813**	1.250	5.625	27.580	13.250	2.875	4.625	12.000	4.625
Channel Catfish	**0.083**	0.000	0.000	0.000	0.125	0.250	0.125	0.000	0.000	0.000	0.000	**0.050**	0.000	0.000	0.125	0.125	0.000	0.000	0.125	0.125
Ictalurus sp.	**0.000**	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.013**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
American Eel	**0.861**	0.000	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.013**	0.000	0.250	0.125	0.000	0.000	0.000	0.250	1.000
Trout-perch	**35.125**	4.750	7.500	0.125	4.500	6.000	12.375	18.375	550.279	226.843	1.750	**83.250**	58.875	4.250	122.986	6.000	165.895	16.000	73.875	18.375
White Perch	**273.179**	10.250	194.882	306.265	3076.179	237.616	794.071	226.216	298.129	811.713	25.250	**598.057**	658.175	276.439	341.366	27.250	24.625	204.583	1118.446	319.683
White Bass	**0.403**	0.000	0.000	0.500	1.625	1.250	4.250	0.375	0.000	1.250	0.250	**0.950**	4.500	0.750	0.000	0.125	4.000	16.500	2.625	0.500
Sunfish	**0.125**	0.375	0.000	0.000	0.000	0.000	1.375	0.000	0.125	0.000	0.000	**0.188**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Rock Bass	**0.014**	0.125	1.750	0.250	0.000	0.000	0.000	0.000	0.000	0.500	0.250	**0.288**	0.000	0.125	0.250	0.000	0.125	0.000	0.250	0.000
Pumpkinseed	**15.042**	118.095	17.500	67.500	19.500	14.750	15.500	19.125	11.500	30.500	11.000	**32.497**	26.000	3.750	9.375	36.500	28.000	63.250	39.375	3.000
Bluegill	**0.014**	0.500	0.125	4.500	0.000	0.125	0.875	0.375	0.000	0.250	1.250	**0.800**	2.750	3.875	1.750	0.125	0.250	0.375	0.625	0.000
Smallmouth Bass	**0.500**	0.500	0.125	1.000	1.250	0.625	0.250	0.000	0.000	0.250	0.000	**0.400**	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Largemouth Bass	**0.083**	0.000	1.125	0.000	0.250	1.125	2.125	0.000	0.125	0.375	2.750	**0.788**	2.375	1.750	5.500	0.000	0.125	7.000	0.375	0.625
Black Crappie	**0.028**	0.125	0.625	0.125	0.000	1.750	1.375	4.875	0.000	3.375	0.125	**1.238**	0.125	0.625	2.875	0.250	6.250	0.125	0.250	0.000
Lepomis sp.	**0.000**	0.000	0.000	0.000	0.000	483.734	0.000	1.000	0.250	0.000	1.875	**48.686**	0.000	0.000	3.250	0.250	0.250	8.000	0.000	0.125
Yellow Perch	**320.934**	412.720	555.437	683.480	152.149	1031.209	638.509	1087.358	531.795	219.331	66.231	**537.822**	1466.894	126.916	247.843	425.715	967.424	656.154	332.890	421.890
Walleye	**17.486**	12.500	2.875	7.500	15.125	5.000	5.250	9.875	19.875	15.875	1.875	**9.575**	11.875	4.875	3.500	22.375	18.875	14.750	10.375	14.750
Johnny Darter	**0.403**	0.625	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.063**	0.000	0.000	0.000	0.250	0.625	0.000	0.125	0.125
Logperch	**0.278**	1.000	0.125	0.375	0.000	3.625	0.125	0.750	2.875	23.625	0.250	**3.275**	2.875	0.000	0.125	1.500	2.000	0.125	0.375	0.125
Brook Silverside	**0.306**	0.000	0.000	0.000	0.000	0.750	0.000	0.000	0.000	0.000	3.000	**0.375**	0.125	2.750	0.125	0.000	0.000	0.625	0.000	0.000
Round Goby	**0.000**	1.250	11.500	16.125	20.625	117.305	4.625	4.250	4.500	2.750	1.625	**18.456**	1.625	13.875	2.000	0.375	10.750	6.875	1.125	4.375
Freshwater Drum	**9.111**	16.500	1.875	15.375	15.625	8.250	22.000	24.000	10.125	11.500	0.875	**12.613**	7.375	7.125	10.375	2.625	2.250	10.250	16.625	46.750
Total catch	**904**	887	900	1451	3403	2021	1738	2511	1863	1457	605	**1684**	3357	1266	1981	1178	1521	2140	2473	1037
Number of species	**16**	20	19	19	16	21	20	16	15	19	20	**19**	20	20	20	18	20	18	21	19
Number of trawls		8	8	8	8	8	8	8	8	8	8		8	8	8	8	8	8	8	8

TABLE 1.2.14. Species-specific catch per trawl (6 min duration; 1/4 mile) by year in the fish community index bottom trawling program at **Big Bay** (5 m depth), Bay of Quinte. Catches are the mean number of fish observed for the number of trawls indicated. Total catch and number of species caught are indicated.

	Year																			
Species	**1992-2000 mean**	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	**2001-2010 mean**	2011	2012	2013	2014	2015	2016	2017	2018
Longnose Gar	**0.111**	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.000	0.000	0.000	**0.025**	0.000	0.000	0.000	0.000	0.000	0.250	0.000	0.000
Alewife	**33.495**	0.000	224.952	0.000	407.516	35.750	13.000	0.375	190.282	37.875	332.829	**124.258**	52.055	122.472	313.093	100.931	36.500	120.414	0.500	60.343
Gizzard Shad	**228.179**	0.000	52.250	23.250	58.375	25.875	2.250	2.250	68.745	0.000	66.222	**29.922**	52.250	82.732	3.375	0.125	99.696	1112.491	3.375	1.875
Rainbow Smelt	**0.039**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.125	0.125
Northern Pike	**0.056**	0.000	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.013**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
White Sucker	**4.031**	0.750	2.875	1.125	1.375	0.875	0.125	0.375	0.375	0.625	3.750	**1.225**	2.500	2.000	1.250	2.875	0.500	1.625	1.125	0.875
Moxostoma sp.	**0.007**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Common Carp	**0.545**	0.250	0.000	0.500	0.375	0.250	0.875	0.125	0.375	0.000	1.000	**0.375**	1.375	0.375	0.125	0.000	0.000	0.500	0.375	0.125
Emerald Shiner	**0.042**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Spottail Shiner	**16.069**	12.125	63.625	8.875	20.250	56.250	18.625	15.375	10.625	19.500	37.625	**26.288**	53.750	92.750	11.000	82.728	43.750	52.625	26.250	11.375
Brown Bullhead	**29.570**	16.375	32.625	38.000	23.750	12.125	54.625	9.750	8.750	3.000	4.750	**20.375**	4.250	1.875	6.375	7.875	1.375	2.625	4.375	3.000
Channel Catfish	**0.151**	0.000	0.125	0.000	0.000	0.125	0.375	0.000	0.000	0.000	0.000	**0.063**	0.000	0.000	0.125	0.500	0.125	0.250	0.125	0.125
Ictalurus sp.	**0.000**	0.375	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.038**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
American Eel	**0.337**	0.125	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.025**	0.000	0.000	0.000	0.000	0.000	0.375	0.000	0.000
Trout-perch	**23.320**	1.375	9.125	5.000	3.125	21.625	21.000	14.000	65.875	67.750	45.625	**25.450**	86.750	40.875	64.250	643.990	71.875	46.000	48.000	50.750
White Perch	**446.656**	18.250	793.237	145.125	1499.098	554.616	1252.318	363.567	456.729	1117.116	190.786	**639.084**	1552.354	240.164	540.939	34.250	52.250	211.330	817.221	138.319
White Bass	**1.221**	0.000	2.125	0.000	0.250	2.625	3.875	0.250	0.750	8.250	0.375	**1.850**	2.375	0.375	0.750	0.625	1.750	1.250	1.875	2.250
Morone sp.	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	17.250
Sunfish	**1.708**	50.000	0.000	0.000	0.000	0.000	25.250	0.000	9.750	0.000	0.000	**8.500**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Rock Bass	**0.000**	0.000	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.013**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pumpkinseed	**18.612**	83.875	64.125	67.625	36.625	3.750	6.875	1.875	5.750	12.125	5.875	**28.850**	10.250	4.500	16.250	2.125	5.875	23.125	11.125	0.250
Bluegill	**1.930**	124.875	13.625	14.625	0.750	9.625	6.750	16.000	3.875	10.375	4.250	**20.475**	13.000	3.250	2.125	2.250	13.625	10.375	12.875	1.375
Smallmouth Bass	**0.032**	0.125	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.038**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Largemouth Bass	**0.000**	0.000	0.250	0.000	0.250	0.000	0.000	0.000	0.125	1.500	1.625	**0.375**	0.125	9.500	1.000	0.000	0.000	0.000	0.000	0.000
Black Crappie	**0.356**	0.625	0.500	0.375	0.375	1.000	2.625	0.250	0.125	0.250	0.000	**0.613**	0.000	0.000	0.000	0.000	0.625	0.125	0.000	0.000
Lepomis sp.	**0.000**	0.000	66.625	0.000	0.000	1060.443	0.000	4.125	56.481	41.500	170.465	**139.964**	0.500	59.625	5.250	10.750	49.250	18.250	1.000	70.625
Yellow Perch	**62.998**	381.125	153.463	107.650	200.266	90.623	99.395	33.750	660.643	197.790	184.258	**210.896**	435.501	121.071	82.625	577.728	164.461	321.134	26.000	50.375
Walleye	**10.485**	7.500	6.125	19.250	16.875	6.500	8.125	8.750	28.125	10.750	7.250	**11.925**	26.750	11.000	4.125	23.375	18.250	10.000	2.875	6.875
Johnny Darter	**0.037**	1.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.150**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Logperch	**0.053**	0.125	0.000	0.250	0.000	0.000	0.125	0.250	3.250	2.250	0.000	**0.625**	0.125	0.000	0.125	3.125	0.000	0.000	0.000	0.125
Brook Silverside	**0.069**	0.000	0.000	0.000	0.000	0.000	0.125	0.000	0.000	0.000	0.375	**0.050**	0.000	1.125	0.625	0.000	0.250	1.500	0.125	0.000
Round Goby	**0.000**	0.000	0.125	1.375	15.750	9.500	4.750	50.423	1.125	0.625	0.375	**8.405**	0.750	1.625	0.625	0.375	1.250	0.000	0.625	1.125
Freshwater Drum	**10.894**	21.750	24.375	9.000	15.625	125.520	178.465	139.361	14.625	11.625	51.500	**59.185**	15.750	31.500	22.750	4.125	6.375	90.201	20.250	42.000
Total catch	**891**	721	1511	442	2301	2017	1700	661	1586	1543	1109	**1359**	2310	827	1077	1498	568	2024	978	459
Number of species	**17**	17	23	15	17	18	20	19	20	17	18	**18**	18	18	20	15	16	19	17	17
Number of trawls		8	8	8	8	8	8	8	8	8	8		8	8	8	8	8	8	8	8

TABLE 1.2.15. Species-specific catch per trawl (6 min duration; 1/4 mile) by year in the fish community index bottom trawling program at **Belleville** (5 m depth), Bay of Quinte. Catches are the mean number of fish observed for the number of trawls indicated. Total catch and number of species caught are indicated.

	Year																		
Species	**1992-2000 mean**	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	**2001-2010 mean**	2011	2012	2013	2014	2015	2016	2017	2018
Sea Lamprey	**0.014**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Longnose Gar	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.000	**0.600**	0.000	0.000	0.000	0.000	0.000	0.125	0.000	0.000
Alewife	**92.034**	0.250	82.375	0.125	11.500	13.875	9.750	0.125	34.875	78.782	59.821	**29.148**	128.250	24.750	272.438	0.000	65.026	27.000	0.375	33.625
Gizzard Shad	**266.440**	99.204	234.375	46.029	581.893	50.571	88.327	73.318	326.992	321.441	500.849	**232.300**	920.843	708.151	1011.184	0.000	204.767	72.884	9.000	910.080
Rainbow Smelt	**0.111**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Northern Pike	**0.111**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mooneye	**0.014**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
White Sucker	**2.648**	0.375	0.375	0.500	0.125	0.000	0.750	0.250	0.250	0.125	0.625	**0.338**	0.125	0.000	0.375	0.250	0.000	0.250	0.125	0.125
Common Carp	**0.319**	0.125	0.125	0.625	0.000	0.500	0.625	0.250	0.125	1.000	1.500	**0.488**	0.000	0.375	0.125	0.125	0.000	0.875	0.500	0.250
Spottail Shiner	**71.584**	10.625	21.500	4.750	3.875	13.250	23.875	3.750	17.375	33.375	8.125	**14.050**	26.750	2.750	13.500	9.250	6.125	76.557	11.625	29.875
Brown Bullhead	**17.824**	32.000	10.875	5.375	17.875	15.000	14.875	9.375	6.000	2.750	6.250	**12.038**	1.250	1.125	1.250	2.375	4.000	3.125	3.625	0.625
Channel Catfish	**0.069**	0.000	0.125	0.125	0.000	0.375	0.000	0.000	0.000	0.000	0.000	**0.063**	0.000	0.250	0.000	0.000	0.000	0.000	0.000	0.375
American Eel	**0.194**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.125	0.000	0.000	0.000
Burbot	**0.014**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Trout-perch	**78.532**	13.000	5.500	12.750	14.375	9.750	4.000	14.250	19.000	32.125	18.625	**14.338**	32.000	22.250	39.125	38.875	21.625	18.000	75.375	46.250
White Perch	**306.900**	6.625	154.625	165.015	1930.129	476.087	880.660	338.969	845.077	1601.655	104.285	**650.313**	394.588	50.125	2494.625	24.375	45.250	175.135	363.391	129.725
White Bass	**1.509**	0.125	3.000	1.625	3.625	2.000	6.000	0.250	1.000	13.375	3.875	**3.488**	13.750	0.750	2.000	1.875	29.750	9.125	0.500	2.375
Sunfish	**4.472**	48.125	0.000	14.625	0.000	0.000	14.500	0.000	42.125	0.000	0.000	**11.938**	0.000	0.000	0.000	0.000	0.000	0.000	1.125	0.000
Rock Bass	**0.236**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.125	0.000	0.000	0.000	0.125	0.000	0.000	0.000
Pumpkinseed	**26.422**	21.750	5.125	1.875	4.125	1.750	1.125	0.875	0.500	0.250	0.375	**3.775**	0.500	0.125	0.375	0.125	0.500	0.500	30.250	2.000
Bluegill	**13.431**	0.250	0.500	0.125	0.000	0.375	1.250	1.875	0.000	0.000	0.625	**0.500**	0.375	0.000	0.125	3.625	0.000	0.375	16.500	0.875
Smallmouth Bass	**0.296**	0.125	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.025**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Largemouth Bass	**0.157**	0.125	0.375	0.250	0.625	0.375	0.000	0.125	0.625	0.000	1.500	**0.400**	0.375	0.375	3.875	0.000	0.000	0.875	0.250	0.375
Black Crappie	**3.389**	0.375	0.000	0.000	0.250	0.125	2.000	0.375	0.250	0.125	0.000	**0.350**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Lepomis sp.	**0.014**	0.000	88.375	0.000	2.375	409.720	0.250	5.125	9.000	17.875	293.990	**82.671**	13.375	30.625	5.625	31.250	20.500	28.625	1.375	18.500
Yellow Perch	**116.494**	37.875	53.250	14.250	66.250	47.375	14.625	78.750	214.729	44.375	300.513	**87.199**	637.039	21.750	40.750	681.156	168.711	95.847	51.000	193.821
Walleye	**13.352**	5.375	0.750	8.500	2.625	2.000	2.750	8.625	18.125	3.500	10.375	**6.263**	8.750	3.500	0.750	18.625	6.375	7.875	2.000	7.875
Johnny Darter	**1.481**	12.500	2.125	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**1.475**	0.000	0.000	0.000	0.125	0.250	0.000	0.000	0.000
Logperch	**0.347**	0.250	0.500	0.125	0.125	0.125	0.000	0.750	1.000	1.000	0.250	**0.413**	0.125	0.000	0.000	1.500	0.625	0.250	0.500	0.000
Brook Silverside	**0.139**	0.000	0.500	0.000	0.000	0.000	1.250	0.000	0.000	0.000	8.500	**1.025**	0.125	2.000	0.000	0.000	0.000	4.125	0.000	0.000
Round Goby	**0.000**	0.000	1.625	67.000	47.250	60.250	7.125	53.875	8.625	30.500	5.875	**28.213**	1.250	6.500	1.250	7.000	39.375	7.000	1.500	2.125
Freshwater Drum	**23.412**	163.750	58.250	20.875	4.375	214.777	87.000	830.175	25.000	31.000	53.375	**148.858**	13.875	17.625	9.250	11.250	27.750	151.597	19.250	30.250
Sculpin sp.	**0.019**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total catch	**1042**	453	724	365	2691	1318	1161	1421	1571	2213	1385	**1330**	2193	893	3897	832	641	680	588	1409
Number of species	**18**	19	21	19	16	18	17	18	17	16	19	**18**	18	16	16	15	16	19	17	17
Number of trawls		8	8	8	8	8	8	8	8	8	8		8	8	8	8	8	8	8	8

TABLE 1.2.16. Species-specific catch per trawl (6 min duration; 1/4 mile) by year in the fish community index bottom trawling program at **Trenton** (4 m depth), Bay of Quinte. Catches are the mean number of fish observed for the number of trawls indicated. Total catch and number of species caught are indicated.

	Year																		
Species	**1992-2000 mean**	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	**2001-2010 mean**	2011	2012	2013	2014	2015	2016	2017	2018
Alewife	**66.911**	149.297	98.611	174.137	8.625	508.870	126.639	24.500	8.750	112.375	26.875	**123.868**	49.500	86.639	354.152	56.754	44.250	96.852	36.000	197.128
Gizzard Shad	**165.299**	4.125	6.375	22.250	0.000	30.375	23.375	1.375	38.500	5.750	84.234	**21.636**	25.625	70.000	4.125	0.000	55.366	8.625	0.125	192.386
Rainbow Smelt	**0.056**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Northern Pike	**0.069**	0.000	0.000	0.000	0.000	0.125	0.000	0.000	0.000	0.000	0.000	**0.013**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mooneye	**0.056**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
White Sucker	**3.000**	0.500	1.625	0.625	1.125	1.875	2.125	2.125	0.375	0.500	0.750	**1.163**	0.625	1.625	0.000	0.125	8.875	0.250	0.250	0.375
Shorthead Redhorse	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.125	0.000	0.000	0.000
Minnow	**0.014**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Common Carp	**0.278**	0.000	0.250	0.000	0.000	0.000	0.250	0.000	0.000	0.000	0.125	**0.063**	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Spottail Shiner	**88.467**	217.425	60.875	60.875	1.250	24.500	41.750	0.000	76.000	148.410	120.061	**75.115**	158.481	189.616	5.875	1.000	86.873	3.625	23.500	97.125
Brown Bullhead	**26.431**	10.625	3.500	4.250	1.125	8.750	3.750	4.500	1.375	0.875	1.500	**4.025**	2.375	3.875	0.125	1.125	3.500	1.375	0.250	6.500
Channel Catfish	**0.236**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.125	0.000	0.125	0.000	0.000	0.000	0.000
American Eel	**0.250**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Banded Killifish	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.125	**0.013**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Burbot	**0.000**	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.013**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Trout-perch	**27.139**	0.500	0.500	0.000	0.000	0.125	0.125	0.000	0.250	1.625	1.500	**0.463**	3.250	1.750	0.000	2.750	1.250	0.500	1.875	20.375
White Perch	**321.116**	54.250	19.875	240.032	80.777	279.018	388.312	29.875	33.750	669.313	16.250	**181.145**	261.900	361.891	27.125	0.250	11.125	72.244	62.875	385.768
White Bass	**0.403**	0.000	0.125	0.000	0.000	0.000	1.250	0.125	0.000	0.875	0.125	**0.250**	1.625	0.250	0.000	0.000	5.125	0.375	0.000	1.625
Sunfish	**13.764**	33.250	0.000	22.375	0.000	0.000	11.500	0.000	0.875	0.000	0.000	**6.800**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Rock Bass	**0.889**	0.625	0.625	0.125	0.000	0.500	2.250	0.000	1.250	2.875	2.250	**1.050**	4.000	0.375	0.500	1.750	1.875	0.000	0.875	3.500
Pumpkinseed	**86.353**	84.750	32.250	88.887	56.794	46.750	20.000	77.522	143.790	66.250	62.250	**67.924**	67.062	40.125	118.617	20.000	63.875	2.625	91.750	22.375
Bluegill	**0.750**	1.125	0.500	1.500	0.875	0.375	3.875	5.250	2.625	0.625	5.125	**2.188**	11.875	1.000	3.875	2.500	1.625	0.000	29.625	21.125
Smallmouth Bass	**0.556**	0.375	0.250	0.500	0.500	0.125	0.000	0.000	0.125	0.250	0.000	**0.213**	0.125	0.000	0.250	0.000	0.000	0.000	0.125	0.000
Largemouth Bass	**2.236**	2.375	2.875	4.625	0.125	6.625	4.250	0.125	6.375	2.750	6.875	**3.700**	14.125	11.250	5.500	0.125	5.500	10.750	0.250	12.250
Black Crappie	**1.681**	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.013**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Lepomis sp.	**0.764**	0.000	64.796	0.000	0.000	59.750	10.250	0.000	17.000	0.625	7.125	**15.955**	24.875	6.500	3.125	5.000	10.250	15.625	0.000	10.375
Yellow Perch	**317.772**	200.638	239.014	544.694	186.465	340.868	130.139	584.825	769.635	1095.367	335.295	**442.694**	1169.504	278.565	892.895	525.098	1009.464	140.827	194.013	653.821
Walleye	**9.764**	9.625	3.625	10.500	1.500	1.875	0.750	4.750	7.375	6.125	2.125	**4.825**	8.000	9.000	0.000	16.000	24.750	2.250	2.000	9.125
Johnny Darter	**5.458**	2.500	7.250	7.625	0.375	0.000	0.000	0.000	0.000	0.000	0.000	**1.775**	0.250	0.250	0.000	0.125	0.000	0.125	0.000	0.875
Logperch	**3.097**	2.000	0.000	15.250	4.250	52.750	0.625	5.625	23.375	32.375	6.875	**14.313**	24.375	4.750	2.625	48.750	12.250	1.000	0.750	15.500
Tessellated Darter	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.250
Brook Silverside	**0.000**	0.000	0.000	0.250	0.000	0.000	0.000	0.125	0.000	0.000	0.125	**0.050**	0.125	0.000	0.000	0.000	0.000	0.500	0.000	0.000
Round Goby	**0.000**	0.000	0.000	2.875	8.500	13.125	5.250	0.750	12.375	34.125	7.375	**8.438**	18.750	12.125	1.875	19.750	32.625	7.000	1.250	14.875
Freshwater Drum	**11.931**	6.750	3.625	2.000	0.375	4.125	4.875	9.500	1.500	4.875	1.375	**3.900**	2.125	1.125	0.000	1.500	3.000	1.250	8.750	7.625
Total catch	**1155**	781	547	1203	353	1381	781	751	1145	2186	688	**982**	1849	1081	1421	703	1382	366	454	1673
Number of species	**20**	20	18	19	15	18	19	15	18	18	20	**18**	21	19	13	17	18	17	17	19
Number of trawls		8	8	8	8	8	8	8	8	8	8		8	8	8	8	8	8	8	8

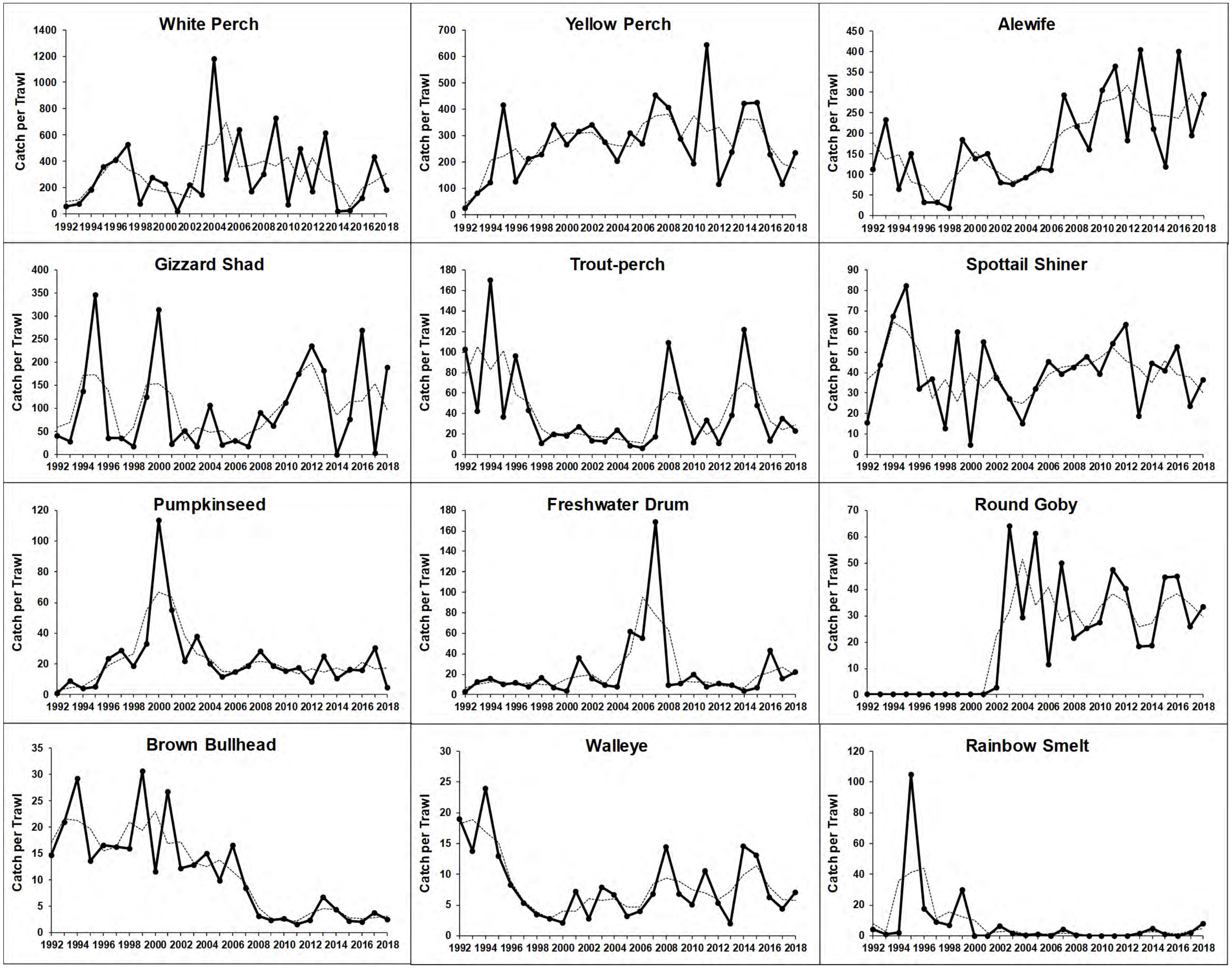


FIG. 1.2.3. Abundance trends (annual means) for the most common species caught in bottom trawls at six sites in the Bay of Quinte (Conway, Hay Bay, Deseronto, Big Bay, Belleville and Trenton; see Fig. 1.2.1). Values shown here are 3-yr running averages (two years for first and last years graphed).

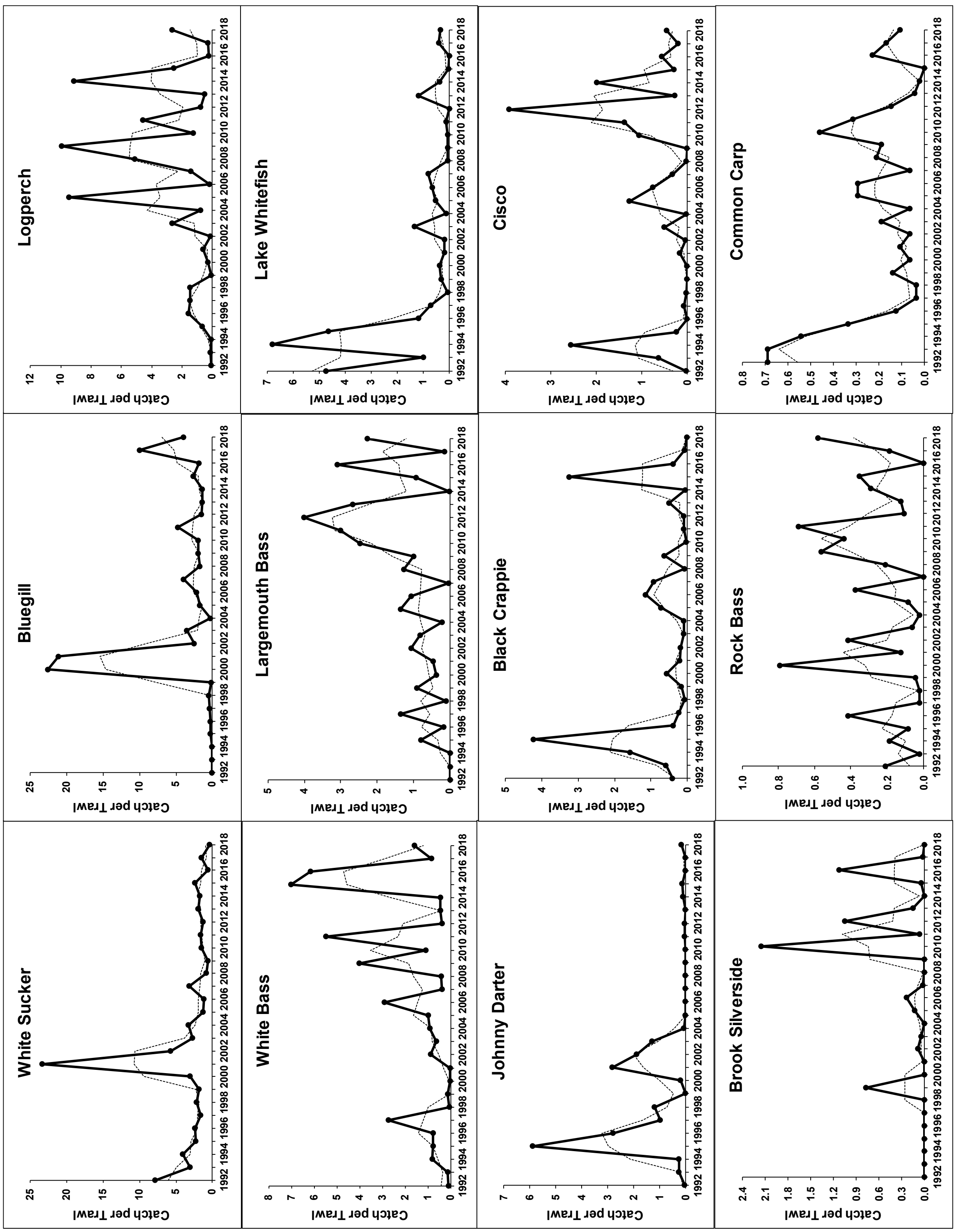


FIG. 1.2.3 (continued). Abundance trends for the most common species caught in bottom trawls at six sites in the Bay of Quinte (Conway, Hay Bay, Deseronto, Big Bay, Belleville and Trenton; see Fig. 1.2.1). Values shown here are 3-yr running averages (two years for first and last years graphed).

TABLE 1.2.17. Mean catch-per-trawl of **age-0 Lake Whitefish** at two sites, Conway in the lower Bay of Quinte and EB03 near Timber Island in eastern Lake Ontario, 1992-2018. Four replicate trawls on each of two to four visits during August and early September were made at each site. Distances of each trawl drag were 1/4 mile for Conway and 1/2 mile for EB03.

	Conway	N	EB03 (Timber Island)	N
1992	23.4	8	0.9	12
1993	3.1	8	4.7	12
1994	40.5	8	79.7	8
1995	27.1	8	17.1	8
1996	2.6	8	0.8	8
1997	5.1	8	6.0	8
1998	0.4	8	0.0	8
1999	0.0	8	0.0	8
2000	0.4	8	0.0	8
2001	0.1	8	0.0	8
2002	0.1	8	0.0	8
2003	8.1	12	44.9	16
2004	0.0	12	2.1	12
2005	2.8	12	49.8	12
2006	2.4	12	3.6	8
2007	0.8	12	0.3	12
2008	0.1	12	0.0	8
2009	0.3	12	0.1	12
2010	0.3	12	4.7	12
2011	0.1	8	0.0	8
2012	0.0	8	0.0	8
2013	7.0	8	0.0	8
2014	2.3	8	0.0	8
2015	0.1	8	0.4	8
2016	0.0	8	0.0	6
2017	2.4	8	0.0	5
2018	1.5	8	0.0	5

in 2016 was fair, in 2017 was poor, and in 2018 was good (Tables 1.2.20 and 1.2.21).

Round Goby first appeared in bottom trawl catches in the Bay of Quinte in 2001 and in the Kingston Basin of eastern Lake Ontario in 2003. The species was caught at all Bay of Quinte trawling sites by 2003, peaking in abundance, at each site, between 2003 and 2005. Catches have been quite variable since but remain high. Round Goby catches in the Kingston Basin remained high in 2018.

TABLE 1.2.18. Mean catch-per-trawl of **age-0 Cisco** at Conway in the lower Bay of Quinte, 1992-2018. Four replicate trawls on each of two to four visits during August and early September were made at the Conway site. Distances of each trawl drag was 1/4 mile.

	Conway	N
1992	0.00	8
1993	1.50	8
1994	7.69	8
1995	1.25	8
1996	0.00	8
1997	0.00	8
1998	0.14	8
1999	0.00	8
2000	0.00	8
2001	0.00	8
2002	0.13	8
2003	2.83	12
2004	0.08	12
2005	7.17	12
2006	4.50	12
2007	2.00	12
2008	0.17	12
2009	0.00	12
2010	6.33	12
2011	8.25	8
2012	23.25	8
2013	1.50	8
2014	11.63	8
2015	1.75	8
2016	3.00	8
2017	1.13	8
2018	2.63	8

TABLE 1.2.19. Mean catch-per-trawl of **age-0 Yellow Perch** at six Bay of Quinte sites, 1992-2018. Four replicate trawls on each of two to three visits during August and early September were made at each site. Distance of each trawl drag was 1/4 mile.

	Trenton	Belleville	Big Bay	Deseronto	Hay Bay	Conway	Mean	Number of trawls
1992	3.1	1.3	0.4	0.1	0.5	0.0	0.9	48
1993	203.7	14.0	0.4	36.3	1.6	0.3	42.7	48
1994	526.6	50.6	10.3	101.5	29.3	6.9	120.8	48
1995	730.4	101.1	9.5	764.5	268.9	0.0	312.4	48
1996	2.6	2.9	4.3	2.5	8.5	0.1	3.5	48
1997	302.0	4.0	36.0	135.0	526.0	0.0	167.2	48
1998	13.1	14.0	11.5	0.1	2.9	0.0	7.0	48
1999	24.5	7.0	4.9	638.7	900.3	0.0	262.6	48
2000	0.0	5.8	5.4	0.8	6.0	0.3	3.0	48
2001	158.0	27.6	16.8	71.8	127.0	0.0	66.9	48
2002	0.0	0.3	9.2	141.8	241.1	0.0	65.4	48
2003	228.5	3.8	0.9	9.2	1.6	0.5	40.8	52
2004	0.0	0.9	4.5	8.4	18.0	0.0	5.3	52
2005	202.8	37.5	24.8	444.7	61.9	0.0	128.6	52
2006	3.8	3.5	51.7	532.8	306.0	0.2	149.7	52
2007	284.3	70.9	29.6	883.5	776.0	0.1	340.7	52
2008	123.8	153.4	114.5	263.6	12.4	0.0	111.3	52
2009	101.3	29.8	130.2	81.1	14.3	0.0	59.4	52
2010	216.8	280.3	167.0	34.6	148.8	0.0	141.2	52
2011	729.7	582.4	382.3	1216.8	4.8	1.7	486.3	53
2012	72.5	16.8	103.6	31.5	38.1	0.1	43.8	48
2013	6.1	8.6	49.5	22.8	9.7	0.0	16.1	48
2014	330.1	223.2	449.3	98.7	48.1	0.0	191.6	48
2015	171.6	83.4	124.3	670.0	224.3	0.0	212.3	48
2016	54.4	92.3	296.4	378.6	36.0	0.0	142.9	48
2017	0.1	5.4	11.3	3.9	3.0	0.0	4.0	48
2018	447.4	189.8	49.1	370.5	47.4	0.1	184.1	48

TABLE 1.2.20. Mean catch-per-trawl of **age-0 Walleye** at six Bay of Quinte sites, 1992-2018. Four replicate trawls on each of two to three visits during August and early September were made at each site. Distance of each trawl drag was 1/4 mile.

Year	Trenton	Belleville	Big Bay	Deseronto	Hay Bay	Conway	Mean	Number of trawls
1992	6.8	12.4	14.0	37.9	6.1	0.8	13.0	48
1993	8.8	16.0	5.0	11.3	1.1	11.9	9.0	48
1994	17.0	21.0	15.0	23.8	11.5	12.5	16.8	48
1995	14.1	8.3	2.6	8.3	5.5	0.9	6.6	48
1996	4.3	7.6	4.9	1.1	0.0	1.1	3.2	48
1997	2.8	7.6	6.1	0.3	0.1	0.0	2.8	48
1998	0.1	0.4	0.6	0.1	0.0	0.0	0.2	48
1999	1.1	0.4	0.4	1.4	9.1	0.1	2.1	48
2000	0.0	3.8	1.0	0.0	0.1	0.0	0.8	48
2001	9.5	4.5	4.8	6.8	3.3	0.1	4.8	48
2002	0.0	0.0	1.1	0.1	0.0	0.0	0.2	48
2003	10.3	8.3	16.8	1.9	0.4	0.0	6.3	52
2004	0.0	0.6	11.4	1.4	0.9	0.0	2.4	52
2005	0.8	1.4	3.8	1.8	1.1	0.0	1.5	52
2006	0.0	1.0	3.0	2.8	5.9	0.3	2.1	52
2007	4.1	6.1	5.4	5.6	5.6	0.2	4.5	52
2008	5.5	17.6	20.5	14.6	12.4	0.0	11.8	52
2009	2.5	2.3	7.6	1.0	2.9	0.0	2.7	52
2010	1.4	4.6	4.5	1.0	3.6	0.0	2.5	52
2011	6.1	8.6	24.5	8.0	4.0	0.1	8.6	52
2012	6.4	2.5	7.1	0.3	0.1	0.0	2.7	48
2013	0.0	0.0	1.0	0.3	0.6	0.0	0.3	48
2014	15.4	18.5	21.0	20.4	6.4	0.0	13.6	44
2015	21.1	5.6	16.6	13.5	7.0	0.0	10.6	48
2016	0.9	5.5	4.9	2.4	0.1	0.0	2.3	48
2017	0.0	0.0	0.3	4.1	5.4	0.0	1.6	48
2018	8.3	7.8	6.1	11.1	2.6	0.0	6.0	48

TABLE 1.2.21. Age distribution of **282 Walleye** sampled from summer bottom trawls, Bay of Quinte, 2018. Also shown are mean fork length and mean weight. Fish of less than 165 mm fork length were assigned an age of 0, fish between 165 and 410 mm were aged using scales; and those over 410 mm fork length were aged using otoliths.

Age (years)	0	1	2	3	4	5	
Year-class	2018	2017	2016	2015	2014	2013	Total
Number of fish	230	25	9	10	7	1	282
Mean fork length (mm)	128	247	350	403	426	552	
Mean weight (g)	20	153	447	714	852	1531	

1.3 Lake Ontario Nearshore Community Index Netting

E. Brown and J. A. Hoyle, Lake Ontario Management Unit

In 2018, Nearshore Community Index Netting (NSCIN) projects were completed at three nearshore areas: Hamilton Harbour, Toronto Harbour, and the Upper Bay of Quinte (Fig. 1.3.1). NSCIN was first initiated on the Upper Bay of Quinte (Trenton to Deseronto), West Lake and Weller's Bay in 2001, and was expanded to include the middle and lower reaches of the Bay of Quinte (Deseronto to Lake Ontario) in 2002. In 2006, the NSCIN program was conducted on Hamilton Harbour and the Toronto Harbour area thanks to partnerships developed with Fisheries and Oceans Canada and the Toronto and Region Conservation Authority. NSCIN was further expanded to other Lake Ontario nearshore areas in subsequent years (Table 1.3.1).

The NSCIN protocol is a provincial standard methodology which uses 6-foot trap nets and is designed to evaluate the relative abundance and other biological attributes of fish species that inhabit the littoral area. Suitable trap net sites are chosen from randomly selected UTM grids that contain shoreline in the nearshore area. Ecosystem (i.e., Index of Biotic Integrity or IBI) and fish community (e.g., proportion of piscivore biomass or PPB) level measures have been developed to assess relative health of Lake Ontario's nearshore areas. These assessments are particularly useful to monitor the on-going status of impaired fish communities in Lake Ontario Areas of Concern (AOCs) such as Hamilton and Toronto Harbours.

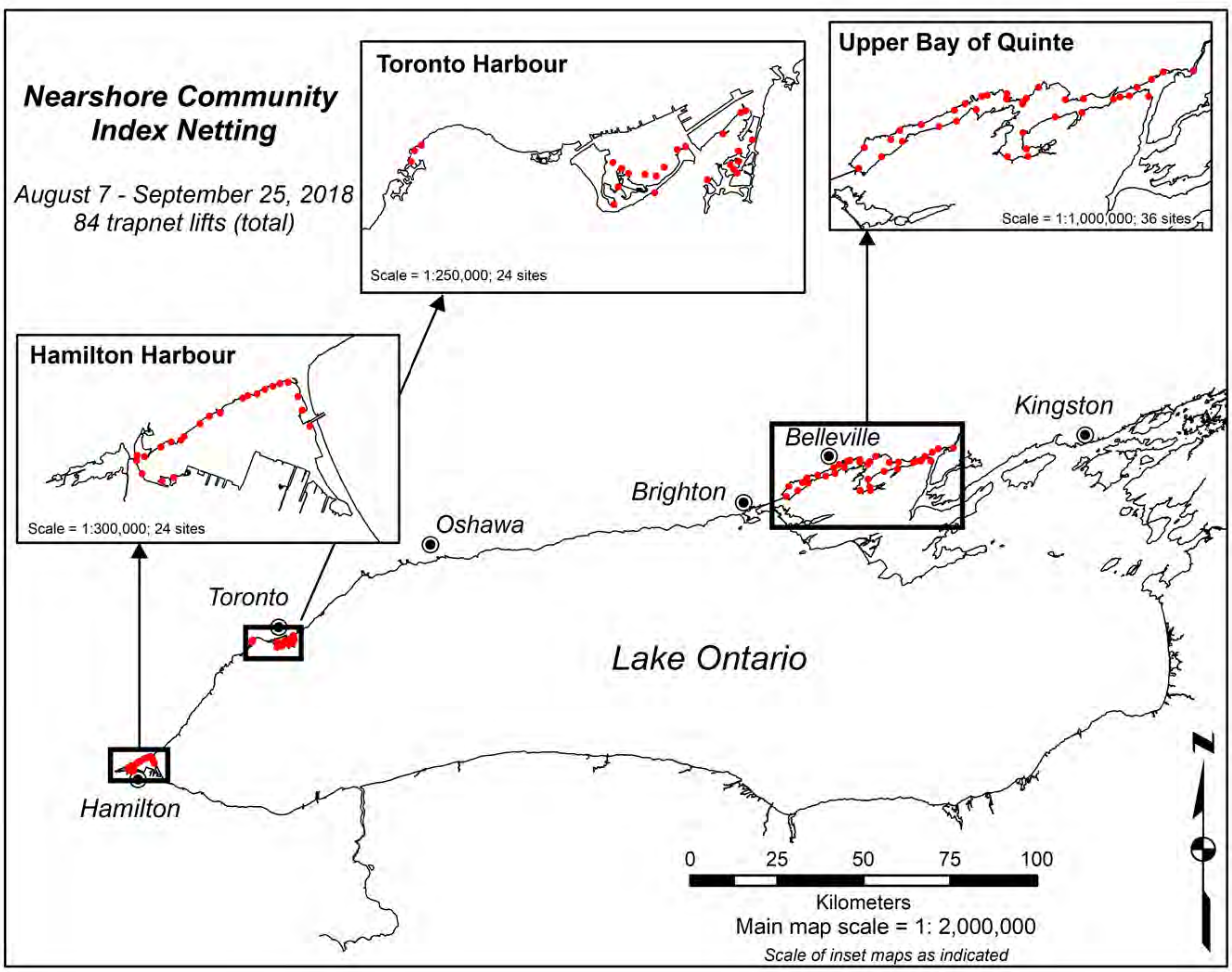


FIG. 1.3.1. Map of Lake Ontario indicating NSCIN trap net locations on Hamilton Harbour, Toronto Harbour and the upper Bay of Quinte, 2018.

Survey information and basic catch statistics for the three nearshore areas sampled in 2018 are given in Tables 1.3.2 and 1.3.3, respectively. Age distribution and length-at-age information is given in Tables 1.3.4 and 1.3.5. Abundance trends for all species are presented in Table 1.3.6 and graphically for selected species in Fig 1.3.2.

Hamilton Harbour

Partnership project with Fisheries and Oceans Canada

Twenty-four trap net sites were sampled in Hamilton Harbour from Aug 7-16 with water temperatures ranging from 20.6 - 26.2°C (Table 1.3.2). Nearly 15,000 fish comprising 25 species were captured (Table 1.3.3). The most abundant species by number were Brown Bullhead (8,535), White Perch (5,055), Bluegill (414), Rudd (354), Goldfish (116), and Common Carp (97). Walleye were the tenth most abundance species (44). Three American Eel and two different exotic species were captured (Tilapia (2) and an Iridescent Shark Catfish (1)).

The catch was subsampled for biological sampling and the age distribution and mean length by age-class of selected species are shown in Tables 1.3.4 and 1.3.5. Abundance trends for all species are presented in Table 1.3.6 and graphically for selected species in Fig. 1.3.2. Walleye have been stocked into Hamilton Harbour in an effort to establish a native predatory fish (see Section 6.1 and Section 8.6). Of particular note was the strong showing of age-6 Walleye from the 2012 stocking event and the apparent absence of Walleye from subsequent events. In 2018 Walleye (age-2) from the 2016 stocking event were then detected.

TABLE. 1.3.1. Annual NSCIN trap net schedule for Lake Ontario nearshore areas, 2001-2018. The numbers of trap net samples at each area in each year are indicated.

Year	Hamilton Harbour	Toronto Harbour	Presqu'ile Bay	Weller's Bay	West Lake	East Lake	Prince Edward Bay	Upper Bay of Quinte	Middle Bay of Quinte	Lower Bay of Quinte	North Channel Kingston
2018	24	24						36			
2017					24	16	24	36			
2016	24	24						36			
2015	24		16	24				36			
2014	24	23						36			
2013					24	16	24	36			
2012	24	24						36			
2011								36	29	7	
2010	24	24						36			
2009							27	36	30	18	25
2008	24		12	24				36			
2007		24			18	18		36			
2006	19	24									

TABLE 1.3.2. Survey information for the 2018 NSCIN trap net program on Hamilton Harbour, Toronto Harbour and the Upper Bay of Quinte, 2018. Shown for each embayment are the survey dates, the range of observed surface water temperatures, the total number of trap net lifts, and the number of trap net lifts broken down by target sampling depth, and observed substrate and cover types.

		Hamilton Harbour	Toronto Harbour	Upper Bay of Quinte
Survey dates		Aug 7-16	Sep 4-13	Sep 4-25
Water temperature range (°C)		20.6-26.2	17.3-22.9	16.2-26.2
No. of trap net lifts		24	24	36
No. of lifts by depth:				
	Target (2-2.5 m)	10	2	17
	> Target	2	15	6
	< Target	12	7	13
No. of lifts by substrate type:				
	Hard	7	1	16
	Soft	17	23	20
No. of lifts by degree of cover:				
	None	15	1	4
	1-25%	8	10	4
	26-75%	1	7	18
	76-100%	0	6	10

Toronto Harbour

Partnership project with Toronto and Region Conservation Authority

Twenty-four trap net sites were sampled on Toronto Harbour from Sep 4-13 with water temperatures ranging from 17.3-22.9°C (Table 1.3.2). Nearly 1,300 fish comprising 20 species were captured (Table 1.3.3). The most abundant species by number were Brown Bullhead (715), Pumpkinseed (258), Alewife (77), Rock Bass (59) and Common Carp (38). No walleye from the 2017 stocking event were observed (see Section 6.1).

Upper Bay of Quinte

Thirty-six trap net sites were sampled on the Upper Bay of Quinte from Sep 4-25 with water temperatures ranging from 16.2 - 26.2°C (Table 1.3.2). Nearly 8,000 fish comprising 27 species were captured (Table 1.3.3). The most abundant species by number were Bluegill (4,261), Pumpkinseed (1,574), Brown Bullhead (278), White Perch (266), Yellow Perch (167), Longnose gar (164), and Black Crappie (155). Twenty-three American Eel were caught.

Northern Pike abundance declined from 2001-2009, increased significantly in 2010, declined from 2010-2013, remained steady until 2015, then increased in 2016. 2016-2018 appears to be a period of stability with an average catch per trap net just below the Bay of Quinte Fisheries Management Plan (FMP) target. Brown Bullhead and Channel Catfish declined from 2001-2009; Brown Bullhead abundance remained low through 2018 and Channel Catfish increased somewhat in 2015-2018. American Eel abundance has been increasing since 2015 with 2018 values surpassing the high abundance levels observed in 2013-2014 and exceeding the Bay of Quinte FMP target. White Perch abundance was unusually high in 2013 but very few were caught in 2014 (7) and 2015 (11). Since 2015, abundance has been increasing.

Pumpkinseed abundance has been variable since 2011; 2018 showed an increase in abundance. Bluegill abundance has been increasing since 2016 with 2018 representing the highest catch since 2011. Smallmouth Bass abundance declined in 2018 and is well bellow the Bay of Quinte FMP target. Aside from a spike in 2011, Largemouth Bass abundance is declining and remains below the Bay of Quinte FMP target. Black Crappie abundance declined slightly in 2018.

Yellow Perch abundance increased in 2018 and remains above the Bay of Quinte FMP target. Walleye abundance, having been unusually high in 2013, declined in 2014 and 2015. An increase in abundance was observed in 2016-2017 as a result of very strong 2014 and 2015 year classes. 2018 was a period of slight decline (Table 1.3.6 and Fig. 1.3.2).

Ecosystem Health Indices

Indices have been developed based on the NSCIN trap netting to evaluate ecosystem health in Lake Ontario nearshore areas. The indices vary among nearshore areas with the degree of exposure of the nearshore area sampled to Lake Ontario, and therefore are presented separately for sheltered and exposed embayments.

Piscivore Biomass

A proportion of the fish community biomass comprised of piscivores (PPB) greater than 0.20 reflects a healthy trophic structure. The PPBs in 2018 were 0.12, 0.17 and 0.36 in Hamilton Harbour, Toronto Harbour and the Upper Bay of Quinte, respectively. The PPB at Hamilton Harbour remained significantly below both 0.2 and that of other sheltered Lake Ontario embayments such as the Upper Bay of Quinte (Fig. 1.3.3). The PPB at Toronto Harbour was just below the target value and that of other exposed Lake Ontario embayments (Fig. 1.3.4).

Index of Biotic Integrity

The index of biotic integrity (IBI) is a measure of ecosystem health. IBI classes can be described as follows: 0-20 very poor, 20-40 poor, 40-60 fair, 60-80 good, and 80-100 excellent ecosystem health. The IBIs were 49 (fair), 41 (fair) and 75 (good) for Hamilton Harbour, Toronto Harbour and Upper Bay of Quinte, respectively. The IBI at Hamilton Harbour remained below those of other sheltered Lake Ontario embayment's, while the IBI at the upper Bay of Quinte was similar to values at other Lake Ontario sheltered nearshore areas (Fig. 1.3.5). Toronto Harbour IBI was lower than other exposed embayments (Fig 1.3.6).

TABLE 1.3.3. Species-specific catch in the 2018 NSCIN trap net program on Hamilton Harbour, Toronto Harbour and the Upper Bay of Quinte. Statistics shown include arithmetic and geometric mean catch-per-trap net (CUE), percent relative standard error of mean log10(catch+1), %RSE = 100*SE/mean, and mean fork or total length (mm). A total of 3 species were caught.

	Hamilton Harbour				Toronto Harbour				Upper Bay of Quinte			
Species	Arithmetic mean	Geometric mean	Relative standard error (%)	Mean length (mm)	Arithmetic mean	Geometric mean	Relative standard error (%)	Mean length (mm)	Arithmetic mean	Geometric mean	Relative standard error (%)	Mean length (mm)
Longnose gar	0.500	0.341	31	780	0.042	0.029	100	560	4.556	1.154	26	834
Bowfin	0.875	0.686	19	559	0.250	0.189	36	583	1.111	0.730	19	597
Alewife	-	-	-	-	3.208	1.468	23	143	-	-	-	-
Gizzard shad	2.083	1.269	19	145	0.833	0.493	30	331	0.806	0.408	29	151
Rainbow trout	-	-	-	-	0.042	0.029	100	500	-	-	-	-
Northern pike	0.333	0.230	37	751	0.875	0.553	27	645	0.556	0.396	22	593
White sucker	0.083	0.059	69	360	0.458	0.319	31	399	0.639	0.376	27	399
Bigmouth buffalo	0.042	0.029	100	640	-	-	-	-	-	-	-	-
Silver redhorse	-	-	-	-	-	-	-	-	0.083	0.059	56	477
Shorthead redhorse	-	-	-	-	-	-	-	-	0.333	0.193	38	405
Greater redhorse	-	-	-	-	-	-	-	-	0.056	0.039	70	540
River redhorse	-	-	-	-	-	-	-	-	0.333	0.193	39	587
Moxostoma sp.	-	-	-	-	-	-	-	-	0.083	0.051	72	-
Goldfish	4.833	3.044	13	318	-	-	-	-	-	-	-	-
Common carp	4.042	2.408	15	507	1.583	1.078	19	673	0.361	0.224	34	625
Golden shiner	-	-	-	-	-	-	-	-	0.333	0.216	33	142
Rudd	14.750	5.518	15	229	-	-	-	-	-	-	-	-
Brown bullhead	355.625	59.112	11	231	29.792	8.569	15	271	7.722	4.366	10	278
Channel catfish	3.917	1.162	30	562	0.125	0.078	71	690	1.917	0.605	30	544
American eel	0.125	0.078	71	803	-	-	-	-	0.639	0.412	25	834
White perch	210.625	87.247	6	182	0.208	0.101	75	200	7.389	1.599	22	193
White bass	0.500	0.284	40	332	0.042	0.029	100	330	0.111	0.071	58	320
Rock bass	2.500	1.349	21	182	2.458	1.450	20	148	3.778	1.583	18	169
Pumpkinseed	1.000	0.625	27	123	10.750	3.604	19	124	43.722	17.676	9	138
Bluegill	17.250	7.587	13	137	0.833	0.428	36	148	118.361	67.766	5	132
Smallmouth bass	0.042	0.029	100	300	0.083	0.059	69	215	0.139	0.092	49	305
Largemouth bass	0.375	0.281	30	346	0.583	0.226	55	160	2.500	1.676	12	262
Black crappie	0.583	0.404	29	164	0.083	0.059	69	170	4.306	2.398	13	256
Lepomis sp.	-	-	-	-	-	-	-	-	0.278	0.180	36	-
Yellow perch	0.458	0.293	36	202	0.708	0.370	37	189	4.639	2.178	16	193
Walleye	1.833	1.032	22	557	-	-	-	-	2.306	1.405	16	471
Freshwater drum	0.458	0.257	43	568	0.292	0.133	69	621	1.500	0.871	19	489
Tilapia	0.083	0.059	69	-	-	-	-	-	-	-	-	-
Iridescent Shark Catfish	0.042	0.029	100	-	-	-	-	-	-	-	-	-
Total catch per net				623				53				209
Number of species				25				20				27
Number of nets				24				24				36
Total catch				14,951				1,278				7,508

Table 1.3.4. Age distribution of selected species caught in Hamilton Harbour, Toronto Harbour and the Upper Bay of Quinte, 2018.

		Age (years) / Year-class											
		0	1	2	3	4	5	6	7	8	9	10	11
Location	Species	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007
Hamilton Harbour													
	Northern Pike	-	1	-	3	-	1	1	-	-	-	-	-
	White Bass	-	1	1	-	1	3	4	-	-	-	-	-
	Pumpkinseed	-	-	20	-	-	-	-	-	-	-	-	-
	Bluegill	-	1	12	18	8	-	-	-	-	-	-	-
	Smallmouth Bass	-	-	1	-	-	-	-	-	-	-	-	-
	Largemouth Bass	1	1	-	1	1	2	2	1	-	-	-	-
	Black Crappie	-	8	2	4	-	-	-	-	-	-	-	-
	Yellow Perch	-	2	3	3	1	-	-	1	-	-	-	-
	Walleye	-	-	10	2	-	-	11	1	-	-	-	-
Toronto Harbour													
	Northern Pike	1	1	5	8	1	2	1	-	1	-	-	-
	Pumpkinseed	-	1	23	6	-	-	-	-	-	-	-	-
	Bluegill	-	-	11	8	-	-	-	-	-	-	-	-
	Smallmouth Bass	-	1	1	-	-	-	-	-	-	-	-	-
	Largemouth Bass	7	4	-	-	1	-	-	-	-	-	-	-
	Black Crappie	-	-	2	-	-	-	-	-	-	-	-	-
	Yellow Perch	-	8	4	3	-	-	-	-	-	-	-	-
Upper Bay of Quinte													
	Pumpkinseed	-	-	9	10	5	2	3	2	-	-	-	-
	Bluegill	-	-	13	5	6	7	4	1	-	-	-	-
	Smallmouth Bass	-	-	4	-	-	-	-	-	1	-	-	-
	Largemouth Bass	9	3	12	6	2	2	-	-	1	-	-	-
	Black Crappie	3	-	14	13	1	1	-	-	-	-	-	-
	Yellow Perch	-	1	4	8	11	4	5	2	-	-	-	-
	Walleye	-	1	1	13	7	-	3	3	-	-	2	1

Table 1.3.5. Mean fork length (mm) of selected species caught in Hamilton Harbour, Toronto Harbour and the Upper Bay of Quinte, 2018

		Age (years) / Year-class											
		0	1	2	3	4	5	6	7	8	9	10	11
Location	Species	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007
Hamilton Harbour													
	Northern Pike	-	534	-	763	-	857	795	-	-	-	-	-
	White Bass	-	234	229	-	313	350	350	-	-	-	-	-
	Pumpkinseed	-	-	119	-	-	-	-	-	-	-	-	-
	Bluegill	-	98	128	145	150	-	-	-	-	-	-	-
	Smallmouth Bass	-	-	300	-	-	-	-	-	-	-	-	-
	Largemouth Bass	130	123	-	350	263	442	430	430	-	-	-	-
	Black Crappie	-	133	181	202	-	-	-	-	-	-	-	-
	Yellow Perch	-	145	194	218	194	-	-	288	-	-	-	-
	Walleye	-	-	410	494	-	-	588	486	-	-	-	-
Toronto Harbour													
	Northern Pike	255	475	574	645	710	772	879	-	578	-	-	-
	Pumpkinseed	-	104	114	133	-	-	-	-	-	-	-	-
	Bluegill	-	-	132	155	-	-	-	-	-	-	-	-
	Smallmouth Bass	-	160	249	-	-	-	-	-	-	-	-	-
	Largemouth Bass	134	149	-	-	331	-	-	-	-	-	-	-
	Black Crappie	-	-	164	-	-	-	-	-	-	-	-	-
	Yellow Perch	-	161	195	228	-	-	-	-	-	-	-	-
Upper Bay of Quinte													
	Pumpkinseed	-	-	118	136	138	149	150	168	-	-	-	-
	Bluegill	-	-	114	144	148	166	156	165	-	-	-	-
	Smallmouth Bass	-	-	264	-	-	-	-	-	482	-	-	-
	Largemouth Bass	140	219	258	334	326	372	-	-	360	-	-	-
	Black Crappie	113	-	234	265	286	302	-	-	-	-	-	-
	Yellow Perch	-	145	154	173	198	242	216	265	-	-	-	-
	Walleye	-	182	372	441	484	-	540	522	-	-	601	583

TABLE 1.3.6. Species-specific abundance trends (mean catch per trap net) in Hamilton Harbour, Toronto Harbour and the Upper Bay of Quinte. Annual total catch per net lift, number of net sets, and number of species are also indicated.

	Hamilton Harbour								Toronto Harbour							Upper Bay of Quinte											
Species	2006	2008	2010	2012	2014	2015	2016	2018	2006	2007	2010	2012	2014	2016	2018	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Longnose gar	0.47	0.71	0.28	0.67	0.17	0.54	0.75	0.50	0.17	-	-	0.04	0.17	0.08	0.04	2.92	0.36	0.44	1.56	0.50	2.08	0.19	1.42	2.22	0.50	2.58	4.56
Spotted gar	-	-	0.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bowfin	0.58	1.17	2.42	1.17	1.54	0.83	1.33	0.88	0.33	0.08	0.46	0.42	0.13	0.54	0.25	0.92	1.11	0.50	0.81	0.75	0.50	0.92	1.31	0.53	0.75	1.39	1.11
Alewife	-	-	-	0.04	0.71	13.75	-	-	3.79	4.58	0.42	9.50	17.91	0.54	3.21	-	-	-	-	-	-	-	-	-	-	-	-
Gizzard shad	3.42	0.50	2.38	2.13	1.21	0.33	1.71	2.08	2.71	0.42	0.04	1.08	0.35	4.04	0.83	0.39	1.00	0.06	0.64	0.14	0.33	0.06	0.25	0.58	1.50	0.67	0.81
Chinook salmon	-	-	-	-	-	-	-	-	0.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rainbow trout	0.05	0.04	-	-	-	-	-	-	-	-	0.04	-	-	0.08	0.04	-	-	-	-	-	-	-	-	-	-	-	-
Atlantic salmon	-	-	-	-	-	-	-	-	-	-	-	-	0.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brown trout	-	-	-	-	0.04	-	-	-	0.04	-	-	0.08	0.13	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake trout	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake whitefish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coregonus sp.	-	-	-	0.25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northern pike	1.11	1.08	1.08	0.29	0.25	0.54	0.54	0.33	1.17	0.83	1.38	1.25	1.00	1.50	0.88	0.44	0.33	0.28	0.83	0.78	0.53	0.28	0.28	0.28	0.53	0.61	0.56
Muskellunge	-	0.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03	-	-	-	-
Mooneye	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Suckers	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quillback	-	0.04	-	-	0.08	-	-	-	-	-	-	-	-	0.04	-	-	-	0.03	-	-	-	-	-	0.03	-	-	-
White sucker	0.11	0.21	0.46	0.29	2.17	0.63	0.04	0.08	4.17	3.83	2.29	1.13	1.17	2.58	0.46	0.44	0.92	0.64	0.44	0.42	0.72	0.86	0.72	0.25	0.61	0.31	0.64
Bigmouth buffalo	0.05	-	-	-	0.04	0.04	-	0.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silver redhorse	-	0.04	-	-	-	-	-	-	-	-	-	-	0.04	-	-	0.64	0.50	1.44	0.44	0.17	0.47	0.83	0.47	0.11	0.19	0.86	0.08
Shorthead redhorse	0.11	0.04	0.25	-	-	-	-	-	0.04	-	-	-	-	-	-	0.19	0.33	0.36	0.06	0.19	0.08	0.31	0.17	0.11	0.03	0.44	0.33
Greater redhorse	-	-	-	-	0.08	0.04	-	-	-	-	-	-	-	-	-	-	0.08	0.06	-	0.44	0.28	0.83	0.11	0.14	0.31	0.22	0.06
River redhorse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.11	0.44	0.03	-	0.14	0.08	0.14	-	0.03	0.47	0.42	0.33
Black buffalo	-	-	-	-	-	0.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Moxostoma sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.08
Minnow	-	0.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Goldfish	0.32	0.92	2.71	0.88	0.58	1.08	3.46	4.83	0.04	-	0.04	-	-	0.25	-	-	-	-	-	-	-	-	-	-	-	-	-
Common carp	4.47	3.92	2.20	1.21	2.25	2.38	4.33	4.04	1.58	2.50	4.75	3.67	2.00	4.79	1.58	0.19	0.22	0.19	0.33	0.22	0.47	0.25	0.25	0.11	0.17	0.19	0.36
Golden shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.22	-	0.06	0.14	0.03	0.06	-	-	0.11	0.03	0.33
Fallfish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03	-	-
Rudd	-	-	-	0.04	-	0.38	3.96	14.75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Black bullhead	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brown bullhead	380.79	189.33	482.67	76.25	251.71	753.79	339.54	355.63	32.63	14.79	8.42	198.00	71.65	160.38	29.79	7.25	6.42	2.56	10.56	13.69	7.11	15.28	6.08	5.75	3.94	3.67	7.72
Channel catfish	34.84	15.92	8.00	14.17	49.58	11.25	12.96	3.92	0.04	-	0.17	0.08	0.04	0.13	0.13	0.72	0.81	0.28	0.53	0.58	0.31	0.06	0.53	0.19	1.03	1.00	1.92
American eel	-	-	-	-	0.08	0.13	0.04	0.13	-	-	-	-	0.09	0.04	-	-	-	-	-	0.11	0.03	0.44	0.28	0.03	0.08	0.14	0.64
White perch	48.42	34.88	84.38	69.92	169.29	132.04	110.88	210.63	0.04	-	0.25	0.92	0.04	0.04	0.21	4.61	4.31	3.86	1.69	3.75	3.58	19.42	0.19	0.31	2.58	2.92	7.39
White bass	2.00	1.75	1.46	0.29	0.75	0.58	0.50	0.50	0.33	-	0.04	0.04	0.22	-	0.04	0.03	0.14	-	-	0.17	0.08	-	-	0.08	0.28	0.14	0.11
Rock bass	0.58	1.08	1.48	1.17	2.00	1.04	3.33	2.50	0.33	1.13	2.58	4.75	1.78	8.71	2.46	4.83	3.97	3.89	2.44	4.50	1.08	7.97	4.92	2.50	2.25	2.06	3.78
Green sunfish	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumpkinseed	0.68	1.13	3.33	2.04	1.00	-	0.67	1.00	7.29	16.29	7.67	12.75	2.48	15.92	10.75	18.61	18.14	23.42	29.08	37.53	28.11	14.72	15.25	50.33	25.06	9.61	43.72
Bluegill	4.05	3.21	9.08	14.42	14.96	3.42	17.33	17.25	0.54	3.96	1.13	2.04	0.87	1.46	0.83	63.92	159.11	71.75	61.50	136.03	74.92	53.56	75.81	62.89	57.53	72.83	118.36
Smallmouth bass	0.11	-	0.13	-	-	-	0.08	0.04	0.04	0.04	0.08	0.08	0.09	0.17	0.08	0.11	0.92	0.56	0.44	0.47	0.14	0.47	0.03	0.06	0.17	0.64	0.14
Largemouth bass	0.26	0.17	0.33	0.25	0.13	0.08	0.17	0.38	1.08	1.25	1.38	5.00	0.61	0.54	0.58	4.53	5.39	4.33	4.25	10.39	2.72	4.33	3.58	3.33	2.42	4.31	2.50
Black crappie	2.32	0.17	0.42	0.58	0.08	-	0.58	0.58	0.83	0.42	0.13	1.13	0.70	0.17	0.08	12.92	17.33	10.03	7.53	8.64	4.78	11.36	5.36	4.22	3.44	5.11	4.31
Lepomis sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.28
Yellow perch	0.11	0.63	4.16	0.25	1.08	0.71	0.58	0.46	1.08	5.96	2.63	20.63	2.17	3.83	0.71	4.72	7.00	2.64	6.11	6.25	1.31	2.69	4.94	3.75	3.86	2.53	4.64
Walleye (Yellow pickerel)	1.05	0.17	0.04	-	2.46	2.04	4.63	1.83	0.38	0.08	-	-	0.09	0.33	-	1.61	2.50	1.75	2.53	2.36	1.44	7.56	1.33	0.94	1.61	5.31	2.31
Round goby	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Freshwater drum	1.37	1.71	1.24	0.33	1.08	1.88	1.33	0.46	1.08	1.29	0.83	0.63	0.83	0.75	0.29	1.25	1.17	1.89	1.97	1.67	2.19	0.94	0.94	0.97	0.72	1.19	1.50
Carassius auratus x Cyprinus carpio	-	-	-	-	-	-	0.25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Notropis hybrids	-	-	-	-	-	-	-	-	-	-	-	-	-	0.04	-	-	-	-	-	-	-	-	-	-	-	-	-
Tilapia	-	-	-	-	-	-	-	0.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iridescent Shark Catfish	-	-	-	-	-	-	-	0.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total catch	488	259	609	187	503	928	509	623	60	57	35	263	105	207	53	131	233	131	134	230	133	144	124	140	110	119	209
Number of net lifts	19	24	24	24	24	24	24	24	24	24	24	24	24	24	24	36	36	36	36	36	36	36	36	36	36	36	36
Number of species	28	25	22	21	25	23	23	25	24	16	20	20	24	24	20	22	24	23	21	25	25	24	23	25	26	25	27

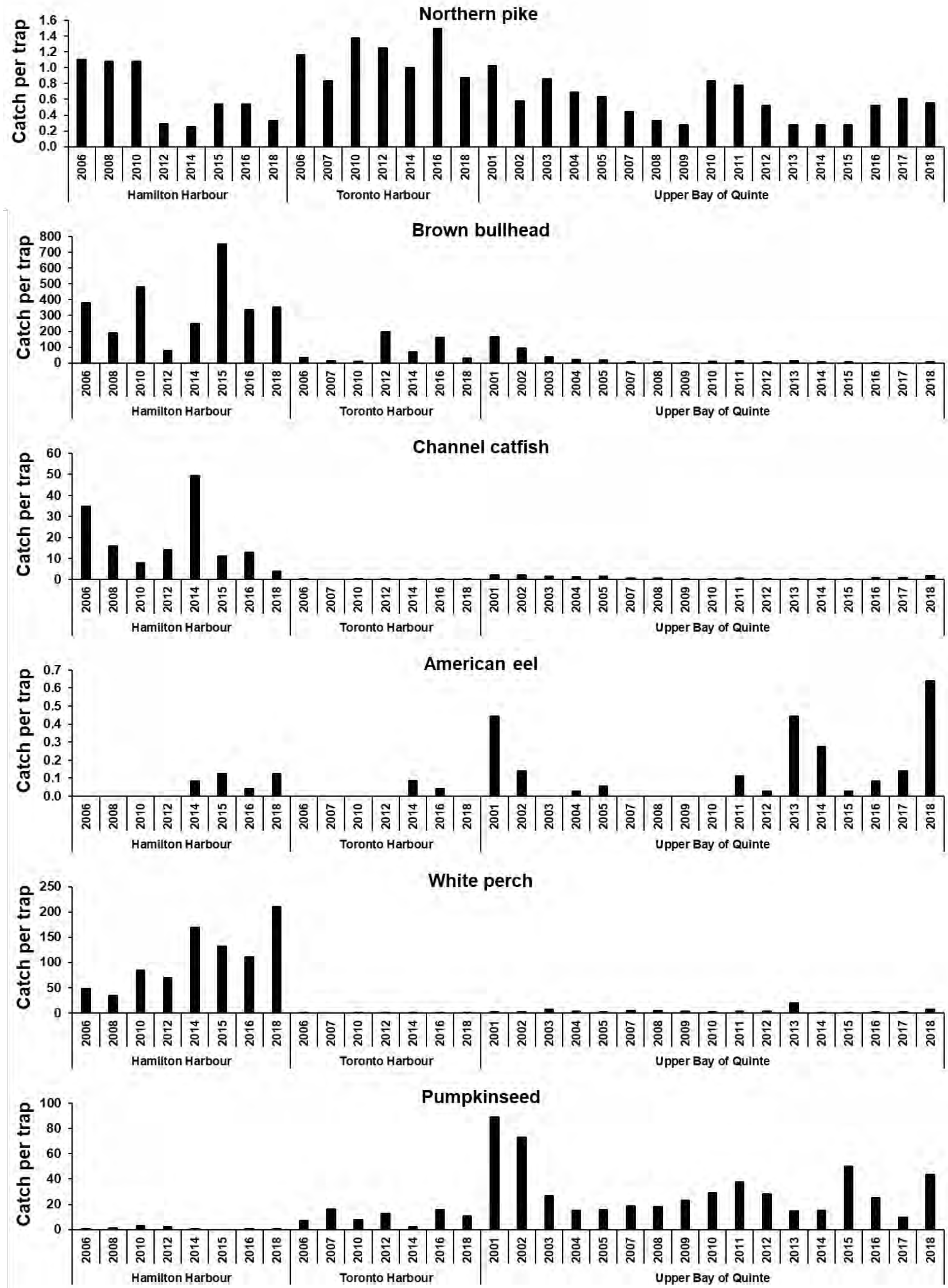


FIG. 1.3.2. Abundance trends for selected species caught in nearshore trap nets in Hamilton Harbour, Toronto Harbour and the Upper Bay of Quinte. Values shown are annual arithmetic means.

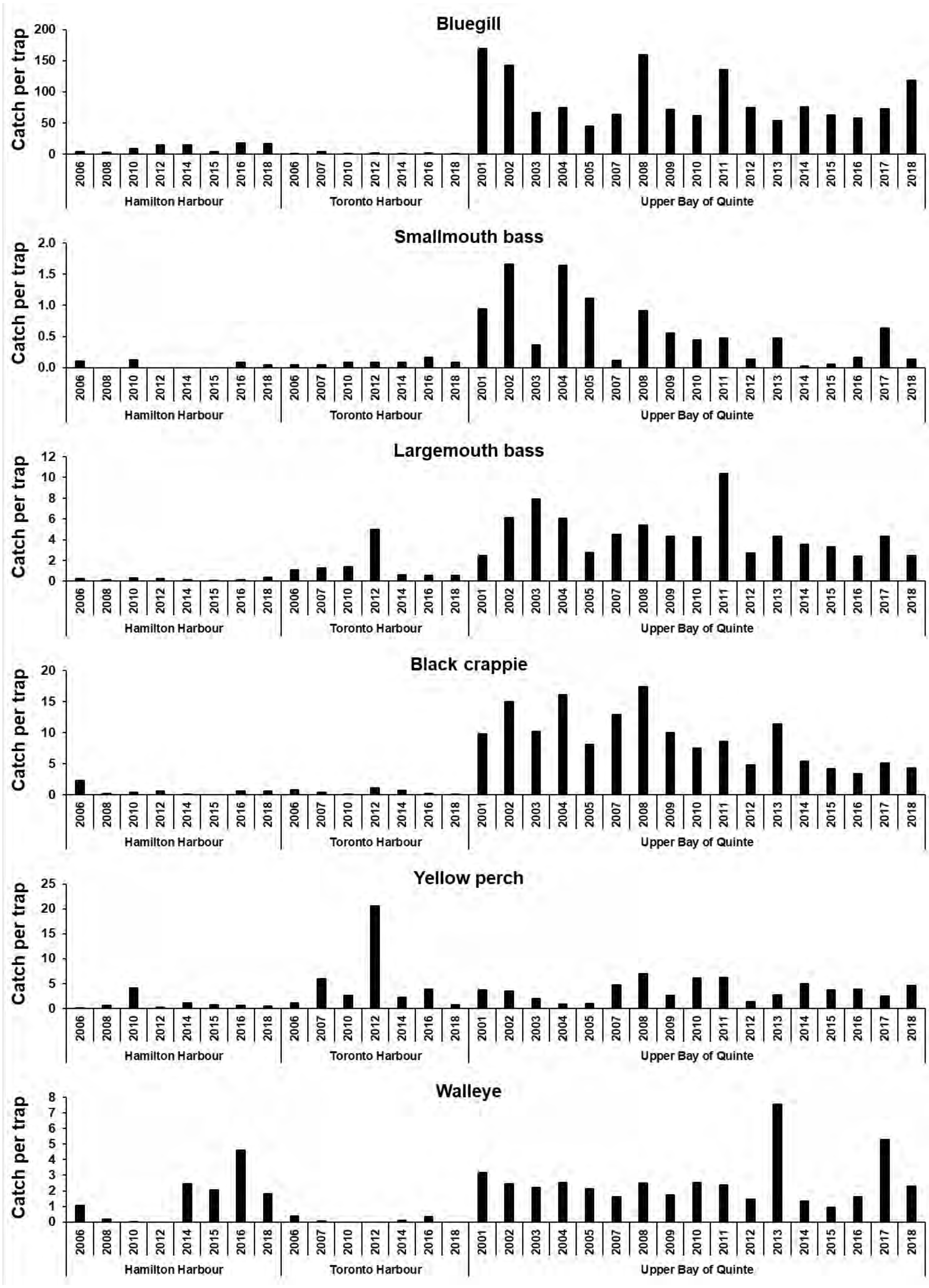


FIG. 1.3.2. (continued) Abundance trends for selected species caught in nearshore trap nets in Hamilton Harbour, Toronto Harbour and the upper Bay of Quinte. Values shown are annual arithmetic means.

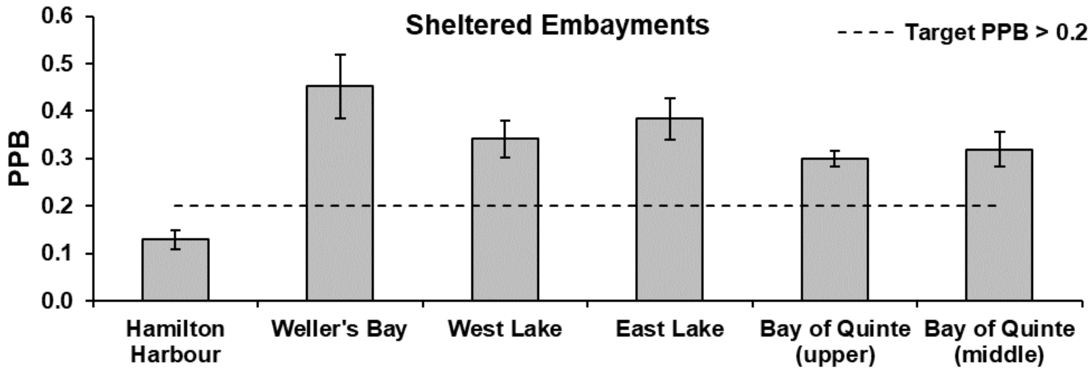


FIG. 1.3.3. Proportion of total fish community biomass represented by piscivore species (PPB) in the nearshore trap net surveys in six sheltered Lake Ontario embayments (2006-2018). A PPB > 0.2 is indicative of a balanced trophic structure (depicted by a dashed line). Piscivore species included Longnose Gar, Bowfin, Northern Pike, Smallmouth Bass, Largemouth Bass, and Walleye. Error bars are ± 2SE.

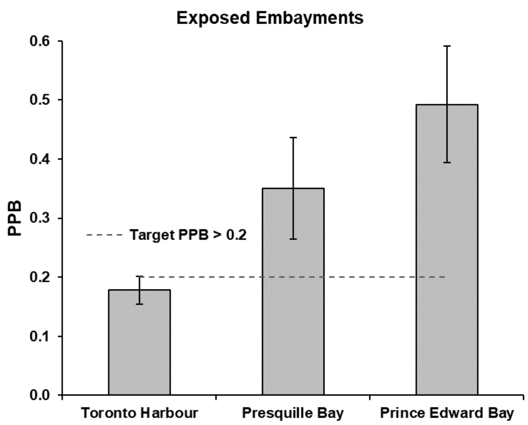


FIG. 1.3.4. Proportion of total fish community biomass represented by piscivore species (PPB) in the nearshore trap net surveys in three exposed Lake Ontario embayments (2006-2018). A PPB > 0.2 is indicative of a balanced trophic structure (depicted by a dashed line). Piscivore species included Longnose Gar, Bowfin, Northern Pike, Smallmouth Bass, Largemouth Bass, and Walleye. Error bars are ± 2SE.

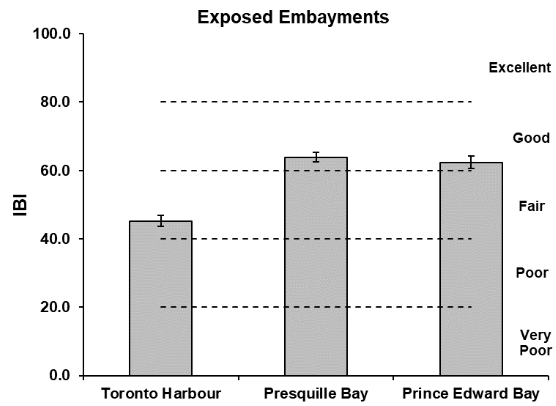


FIG. 1.3.6. Index of biotic integrity (IBI), as a measure of ecosystem health, in the nearshore trap net surveys in three exposed Lake Ontario embayments (2006-2018). IBI classes can be described as follows: 0-20 very poor, 20-40 poor, 40-60 fair, 60-80 good, and 80-100 excellent ecosystem health. Error bars are ± 2SE.

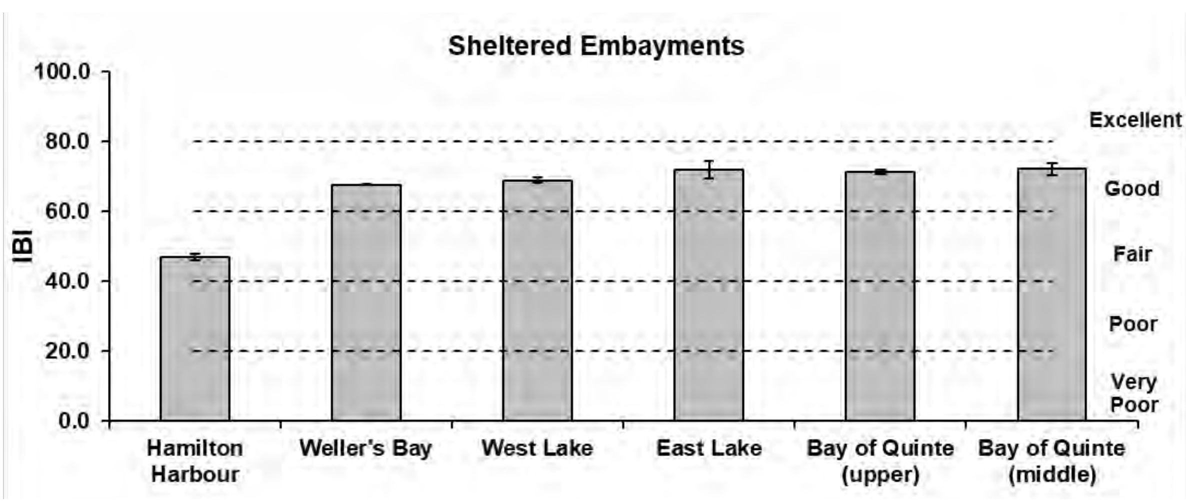


FIG. 1.3.5. Index of biotic integrity (IBI), as a measure of ecosystem health, in the nearshore trap net surveys in five sheltered Lake Ontario embayments (2006-2018). IBI classes can be described as follows: 0-20 very poor, 20-40 poor, 40-60 fair, 60-80 good, and 80-100 excellent ecosystem health. Error bars are ± 2SE.

1.4 Ganaraska River Fishway Migratory Salmon and Trout Assessment

M. J. Yuille, Lake Ontario Management Unit

Lake Ontario is home to a multi-million dollar recreational salmon and trout fishery and its tributaries provide spawning habitat to several migratory salmon and trout species, such as, Rainbow Trout, Brown Trout, Chinook Salmon and Coho Salmon. In the spring of 2016, the Lake Ontario Management Unit (LOMU) purchased new in-river fish counting technology to assess salmon and trout activity in the Ganaraska River fishway, Corbett Dam, Ganaraska River, Port Hope. Understanding migration timing and patterns of these species is critical to evaluate the success of restoration efforts and to determine potential overlap between species when using essential spawning and nursery areas. Monitoring and counting these fish during their spawning migration provides LOMU with an index of the species population status in Lake Ontario.

This fish counter technology (known as the Riverwatcher) automatically counts fish as they pass through the counting tunnel and records both a silhouette image and short, high resolution video for each individual fish. This section includes a summary of the Ganaraska River Riverwatcher data (available at: www.riverwatcherdaily.is/frontpage.aspx?CtrID=133&A=1) as well as the Ganaraska River Chinook Salmon Spawning Index.

The Riverwatcher was installed in the Ganaraska Fishway on March 26th, 2018 and continued to count fish through to November 22nd, 2018. In this time, 25,650 migratory salmon and trout passed upstream through the Ganaraska Fishway (Figs. 1.4.1 and 1.4.2). The number of events recorded is a conservative estimate. During periods of heavy rainfall river flows increased, making the water cloudy. As the water became less clear, the light from the infrared counting sensors could not penetrate through the water, thus fish could not be counted. During these periods of high flow and turbid water, we did not have the capacity to count fish as they moved through the fishway. Additionally, there were occasions throughout the monitoring period where the volume of fish moving through the fish counter exceeded the system's ability to count them individually. Calibration of the system using manual hand counts was initiated in 2017 and is

TABLE 1.4.1. Observed count and estimated run of Rainbow Trout moving upstream at the Ganaraska River fishway at Port Hope, Ontario during spring, 1974-2018. Estimates for 1980, 1982, 1984, 1986, 1992, and 2002 were interpolated from adjacent years with virtual population analysis. Estimate from 2017 to present utilized the Riverwatcher fish counting system.

Year	Observed	Estimated
1974	527	527
1975	591	591
1976	1,281	1,281
1977	2,237	2,237
1978	2,724	2,724
1979	4,004	4,004
1980	--	5,817
1981	7,306	7,306
1982	--	10,127
1983	7,907	7,907
1984	--	8,277
1985	14,188	14,188
1986	--	12,785
1987	10,603	13,144
1988	10,983	15,154
1989	13,121	18,169
1990	10,184	14,888
1991	9,366	13,804
1992	--	12,905
1993	7,233	8,860
1994	6,249	7,749
1995	7,859	9,262
1996	8,084	9,454
1997	7,696	8,768
1998	3,808	5,288
1999	5,706	6,442
2000	3,382	4,050
2001	5,365	6,527
2002	--	5,652
2003	3,897	4,494
2004	4,452	5,308
2005	4,417	5,055
2006	5,171	5,877
2007	3,641	4,057
2008	3,963	4,713
2009	3,290	4,502
2010	4,705	6,923
2011	6,313	9,058
2012	7,256	8,486
2013	8,761	12,021
2014	8,218	9,611
2015	5,890	6,669
2016	4,225	4,987
2017	6,952	--
2018	9,014	--

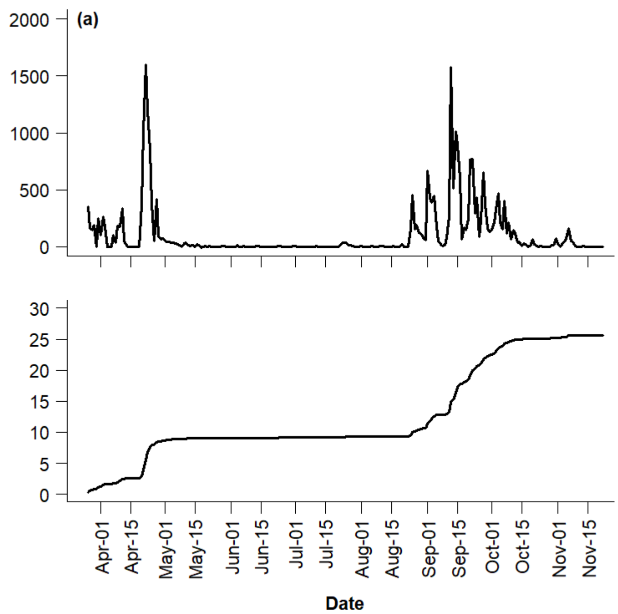


FIG. 1.4.1. (a) Daily and (b) cumulative observed fish counts at the Ganaraska River fishway at Port Hope, Ontario from March 26th to November 22nd, 2018.

ongoing to provide estimates of fish missed during these periods of high turbidity and high fish volume.

April 22nd, 2018 marked the most active day on the fishway with a total of 1,601 Rainbow Trout observed migrating upstream through the Riverwatcher. In the fall, September 12th, 2018 recorded the most upstream events through the Riverwatcher with 1,576 salmon and trout (Figs. 1.4.1 and 1.4.2). Throughout the monitoring period, data on Rainbow Trout, Chinook Salmon, Coho Salmon, Brown Trout and Atlantic Salmon were collected. The following paragraphs provide species specific observations.

Rainbow Trout

The number of Rainbow Trout "running-up" the Ganaraska River during spring to spawn has been estimated at the fishway on Corbett Dam, Port Hope, ON since 1974. Prior to 1987, the Rainbow Trout counts at the fishway were

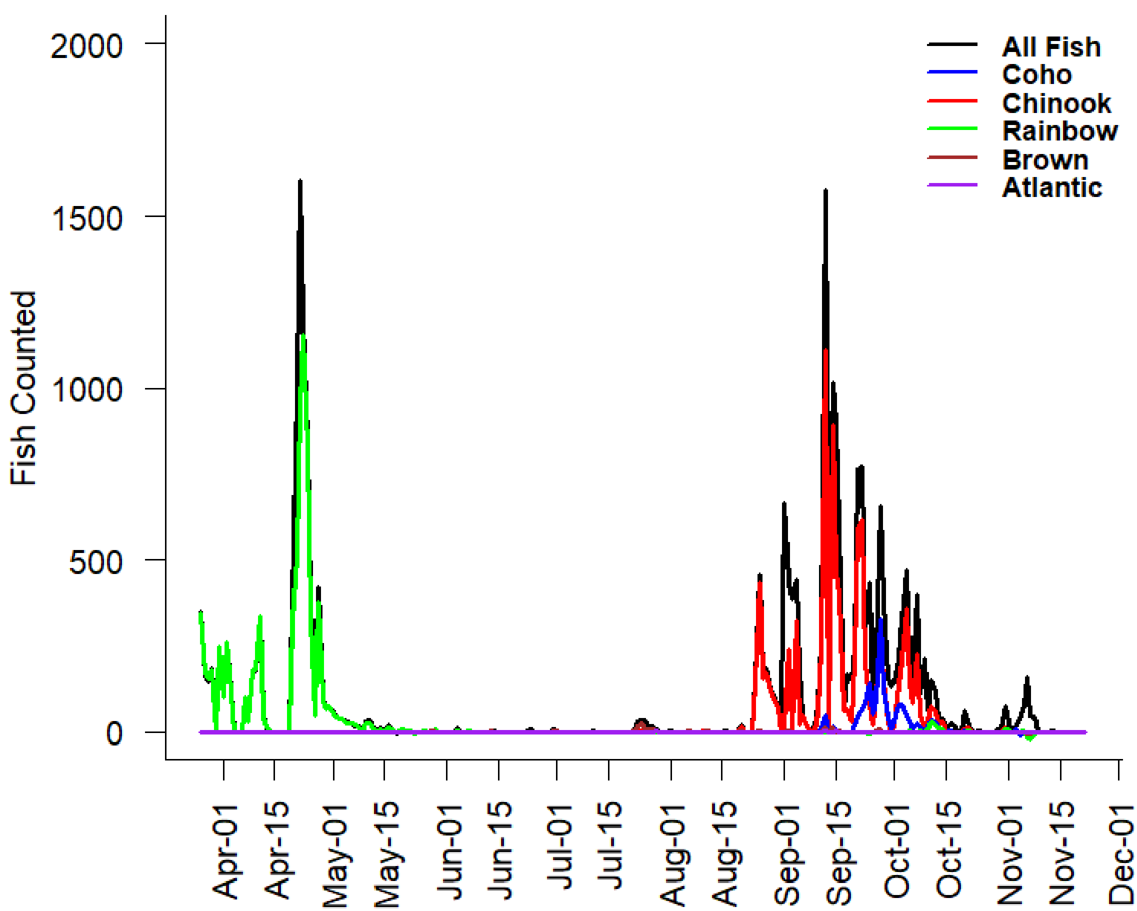


FIG. 1.4.2. Daily counts of each species of salmon and trout observed migrating through the Ganaraska River fishway at Port Hope, Ontario from March 26th to November 22nd, 2018.

based completely on hand lifts and visual counts. Between 1987 and 2016, fish counts were made with a Pulsar Model 550 electronic fish counter. Based on visual counts the Pulsar counter was about 85.5% efficient, and the complete size of the run was estimated accordingly. In years where no observations were made, the run was estimated with virtual population analysis. The counter is usually operated from mid to late March until early May. In 2018, the count of Rainbow Trout migrating upstream through the Corbett Dam was determined using the Riverwatcher fish counting system. The Riverwatcher actively counted and recorded fish from March 26th to May 15th, 2018 when the Rainbow Trout spawning run ended.

In the spring of 2018, 9,014 Rainbow Trout were observed passing through the Ganaraska Fishway (Table 1.4.1 and Figs. 1.4.3 and 1.4.4). This is above the average for the previous 10 years (7,392 fish on average from 2008 to 2017).

TABLE 1.4.2. Body condition (estimated weight at 635 mm total length) of Rainbow Trout at the Ganaraska River fishway at Port Hope, Ontario during spring, 1974-2018.

Year	Male		Female	
	Weight (g)	Sample Size	Weight (g)	Sample Size
1974	3,024	183	3,133	242
1975	2,826	202	3,018	292
1976	3,144	447	3,280	624
1977	2,906	698	3,128	1038
1978	3,053	275	3,271	538
1979	3,132	372	3,285	646
1981	3,131	282	3,304	493
1983	2,884	327	3,025	481
1985	3,118	446	3,274	760
1987	2,875	84	2,966	110
1990	2,851	261	3,043	198
1991	2,793	127	3,032	289
1992	2,946	142	3,072	167
1993	2,899	89	3,093	172
1994	3,088	116	3,274	181
1995	2,947	147	3,019	155
1997	3,107	157	3,109	148
1998	3,014	131	3,081	262
1999	2,990	182	3,149	293
2000	3,049	125	3,190	234
2001	2,865	308	3,022	299
2003	2,972	93	3,095	144
2004	3,008	143	3,155	248
2005	3,911	145	3,061	176
2006	2,936	102	3,099	217
2007	2,854	75	2,972	131
2008	2,846	125	2,996	148
2009	2,753	78	2,954	211
2010	2,989	74	3,102	156
2011	2,913	94	3,083	204
2013	3,044	163	3,178	217
2015	2,752	86	2,921	119
2016	2,801	105	2,942	132
2017	2,877	94	3,016	106
2018	2,785	249	2,930	407
Average	2,974		3,093	

TABLE 1.4.3. Lamprey marks on Rainbow Trout in spring 1990-2018, at the Ganaraska River fishway, at Port Hope, Ontario. Since 1990, A1 and A2 marks were called wounds and the remainder of marks were called scars to fit with historical classification.

Year	Wounds /fish	Scars /fish	Marks/ fish	% with wounds	% with scars	% with marks	Sample Size
1974	0.083	0.676	0.759	7.0	33.2	37	527
1975	0.095	0.725	0.820	8.0	37.2	40	599
1976	0.090	0.355	0.445	6.6	23.3	28	1280
1977	0.076	0.178	0.254	6.4	13.5	18	2242
1978	0.097	0.380	0.476	8.1	28.4	34	2722
1979	0.122	0.312	0.434	10.3	22.8	30	3926
1981	--	--	0.516	--	--	36	5489
1983	0.113	0.456	0.569	9.7	33.4	39	833
1985	0.040	0.154	0.193	3.7	11.5	14	1256
1990	0.030	0.071	0.101	2.8	5.8	8	466
1991	0.026	0.076	0.103	2.4	6.4	8	419
1992	0.079	0.117	0.197	6.3	11.1	17	315
1993	0.077	0.126	0.203	6.9	11.5	17	261
1994	0.044	0.141	0.185	4.0	12.4	15	298
1995	0.036	0.026	0.063	3.6	2.6	6	303
1996	0.028	0.025	0.053	2.8	2.5	5	396
1997	0.035	0.132	0.167	3.5	10.3	13	311
1998	0.075	0.092	0.168	6.8	8.5	13	400
1999	0.057	0.157	0.214	5.5	12.4	16	477
2000	0.091	0.191	0.283	8.0	16.9	24	361
2001	0.118	0.138	0.257	10.0	12.5	19	608
2003	0.063	0.134	0.197	5.9	10.9	16	238
2004	0.227	0.316	0.543	17.6	25.0	38	392
2005	0.231	0.433	0.664	17.1	33.6	41	321
2006	0.282	0.379	0.661	22.6	30.1	45	319
2007	0.199	0.534	0.733	15.5	39.3	49	206
2008	0.274	0.682	0.956	18.6	43.8	51	274
2009	0.256	0.377	0.633	20.4	29.8	42	289
2010	0.134	0.394	0.528	10.4	31.2	38	231
2011	0.124	0.235	0.359	10.7	21.8	30	298
2013	0.229	0.071	0.300	17.4	6.8	22	380
2015	0.058	0.238	0.296	4.9	16.5	20	206
2016	0.075	0.280	0.356	7.5	21.8	27	239
2017	0.109	0.183	0.292	10.9	16.8	27	202
2018	0.093	0.108	0.201	8.5	9.9	17	658

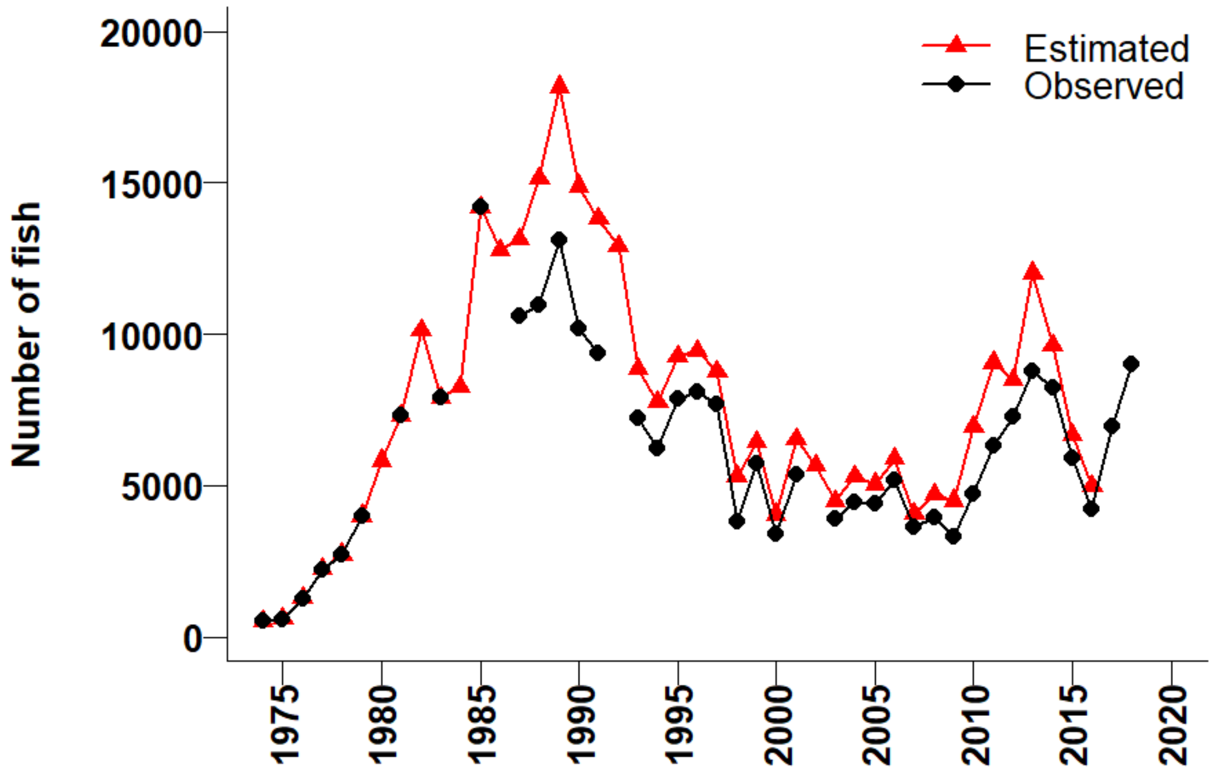


FIG. 1.4.3. Estimated and observed run of Rainbow Trout at the Ganaraska River fishway at Port Hope, Ontario during spring 1974-2018.

The total observed run size from 2018 increased 30% from 2017 and is 25% below the peak estimated run in 2013 (Table 1.4.1 and Fig. 1.4.3). The 2018 spawning run estimate marks the second consecutive increase on the Ganaraska River since the 2013 peak. In the spring, the fishway was most active mid-April, which is comparable to previous runs (Fig. 1.4.4). In just four days (April 21st – April 24th, 2018), 48% of the Rainbow Trout counted passed through the fish counter (Fig. 1.4.4).

Rainbow Trout were measured and weighed during the spawning run in most years since 1974. Rainbow Trout body condition was determined as the estimated weight of a 635 mm (25 inch) total length fish. In 2018, the condition of male (2,785 g) and female (3,024 g) Rainbow Trout were slightly lower than both the 2017 values and the previous 10-year average (Fig 1.4.5 and Table 1.4.2).

The proportion of Rainbow Trout with Lamprey marks in the Ganaraska River has been reported since 1974. In 2018, 17% of fish had Lamprey marks (wound or scar), which is 10% lower than 2017 (Fig. 1.4.6 and Table 1.4.3). Lamprey wounds on Ganaraska River Rainbow Trout in 2018 remain below the previous 10 year average (35%; Table 1.4.3).

Chinook Salmon

A total of 9,067 Chinook Salmon were identified migrating upstream through the Riverwatcher in the Ganaraska Fishway in 2018. The first Chinook Salmon was observed July 23rd, 2018; this is well ahead of the main Chinook Salmon spawning run (Fig. 1.4.7). Staff sampled a total of 677 Chinook Salmon from September 24th to October 16th, 2018. From the total, 149 fish were sampled in detail and the ages of these Chinook Salmon were interpreted from otoliths. Using this information, an age-length-key was created to assign ages to the remaining 528 Chinook Salmon. Through this process it was determined that the 2018 fall Chinook run was comprised of 1% age-1 (all male), 72% age-2 (73% male and 27% female), 23% age 3 (55% male and 45% female) and 3% age-4 (all female; Fig. 1.4.8). In 2018, the average weight for age-2 males and females was 5,402 g and 5,960 g

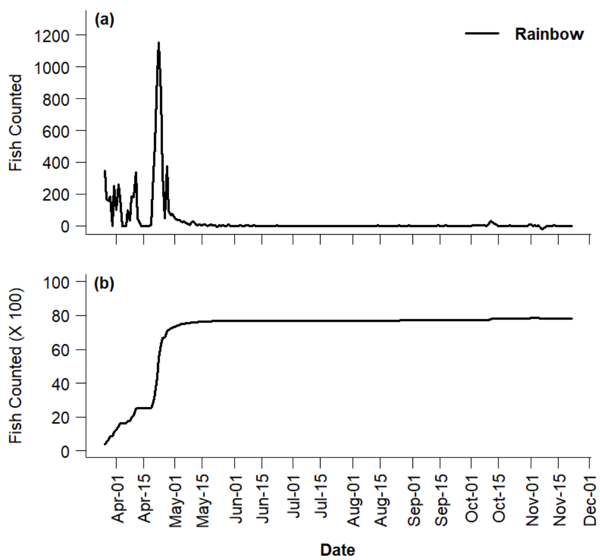


FIG. 1.4.4. (a) Daily and (b) cumulative observed counts of Rainbow Trout at the Ganaraska River fishway at Port Hope, Ontario from March 26th to November 22nd, 2018.

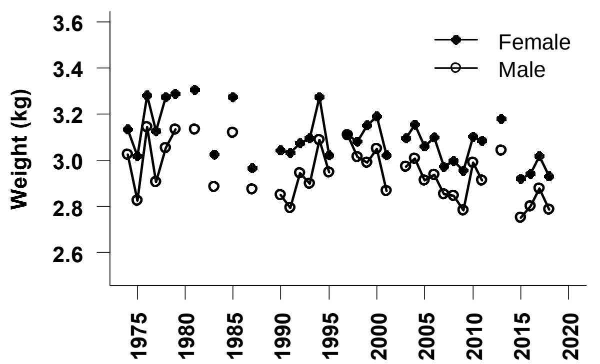


FIG. 1.4.5. Body condition (estimated weight at 635 mm total length) of Rainbow Trout at the Ganaraska River fishway at Port Hope, Ontario during spring 1974-2017. Open and closed circles represent male and female Rainbow Trout (respectively).

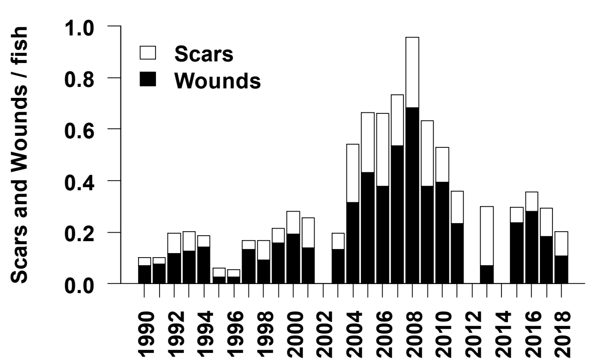


FIG. 1.4.6. Trend in lamprey marks on Rainbow Trout during the spring 1990-2017, at the Ganaraska River fishway at Port Hope, Ontario. Since 1990, A1 and A2 marks (King and Edsall 1979) were called wounds and the remainder of marks were called scars to fit with historical classification.

(respectively) and the average weight for age-3 males and females was 7,589 g and 7,466 g (respectively; Fig. 1.4.9). Condition measured as the mean weight of a 914 mm or 36 inch (total length) Chinook Salmon in the Ganaraska River has declined for females and remained stable for males since 2015 (Fig. 1.4.10).

Coho Salmon

In 2018, 1,550 Coho Salmon migrated upstream through the Ganaraska Fishway (Fig. 1.4.11). The first Coho Salmon observed at the Ganaraska Fishway in 2018 was on September 2nd and the last was observed on November 13th (Fig. 1.4.11).

Brown Trout

A total of 183 Brown Trout migrated upstream through the Ganaraska Fishway (Fig. 1.4.12). The first Brown Trout observed at the Ganaraska Fishway in 2018 was on March 31st. Of the Brown Trout identified passing through the fishway, the majority were observed in late-July (Fig. 1.4.12).

Atlantic Salmon

The first Atlantic Salmon observed at the Ganaraska Fishway in 2018 was on July 27th. During the monitoring period, a total of 23 Atlantic Salmon were identified moving upstream from the Corbett Dam (Fig. 1.4.13).

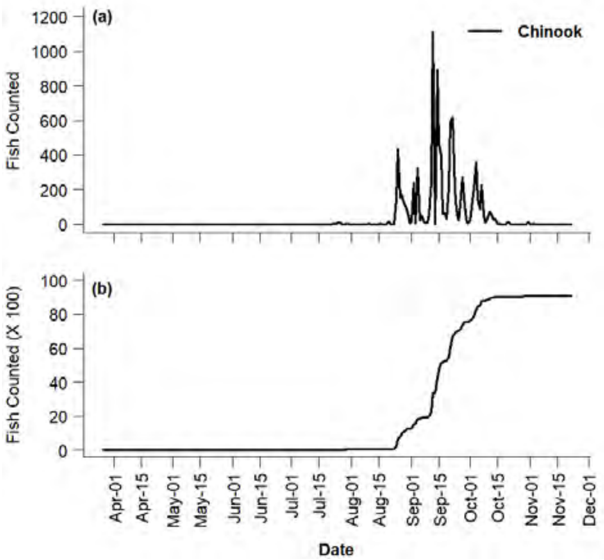


FIG. 1.4.7. (a) Daily and (b) cumulative observed counts of Chinook Salmon at the Ganaraska River fishway at Port Hope, Ontario from March 26th to November 22nd, 2018.

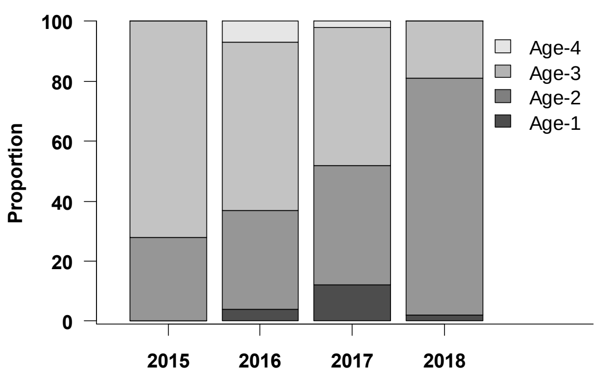


FIG. 1.4.8. Age proportions of spawning Chinook Salmon (males and females pooled) sampled during the fall Ganaraska River Chinook Salmon Spawning Index, Port Hope, Ontario from 2015 – 2018. The four grey colours correspond to each age where Age 1 is the darkest and Age 4 is the lightest.

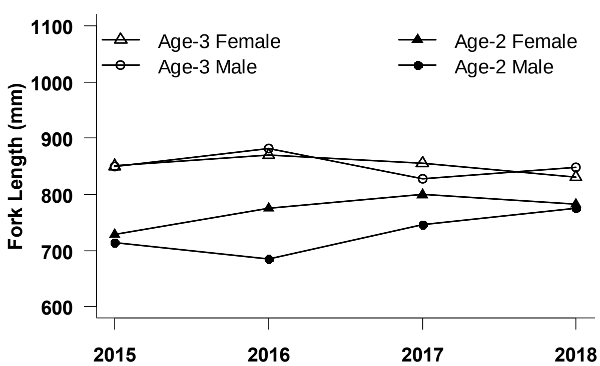


FIG. 1.4.9. Mean fork length of age-2 and age-3 Chinook Salmon by sex, caught for spawn collection in the Ganaraska River during the fall spawning run (approximately first week of October), 2015-2018.

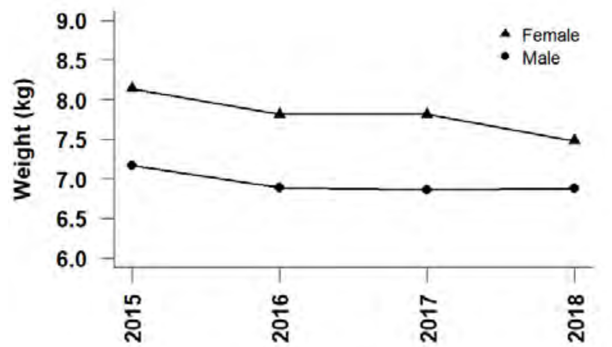


FIG. 1.4.10. Condition index as the mean weight of a 914 mm / 36 inch (total length) Chinook Salmon in the Ganaraska River during the spawning run (approximately first week of October), 2015-2018.

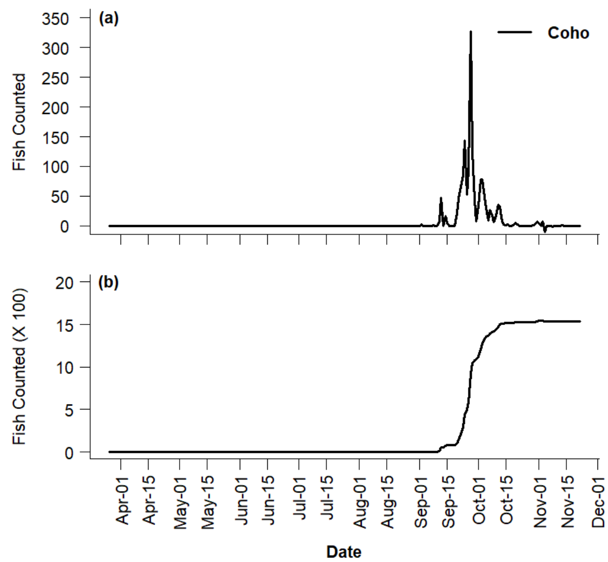


FIG. 1.4.11. (a) Daily and (b) cumulative observed counts of Coho Salmon at the Ganaraska River fishway at Port Hope, Ontario from March 26th to November 22nd, 2018.

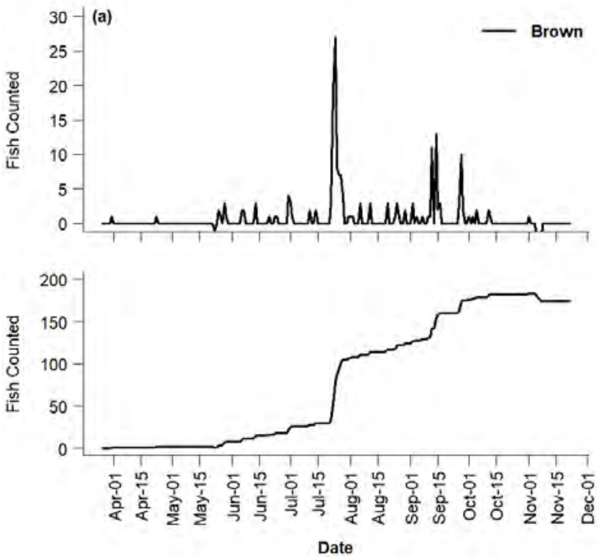


FIG. 1.4.12. (a) Daily and (b) cumulative observed counts of Brown Trout at the Ganaraska River fishway at Port Hope, Ontario from March 26th to November 22nd, 2018

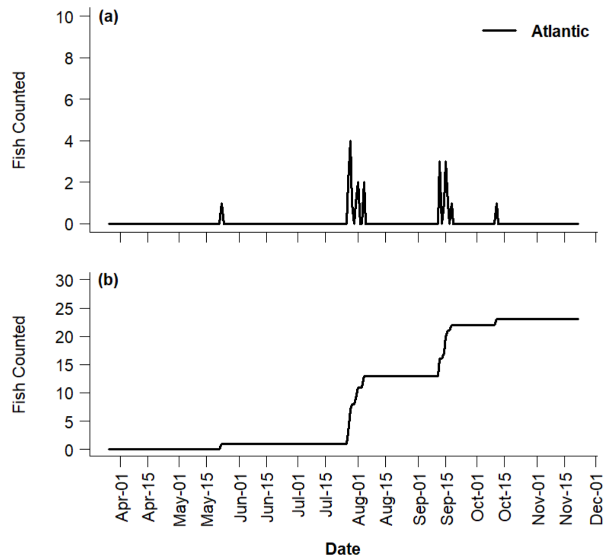


FIG. 1.4.13. (a) Daily and (b) cumulative observed counts of Atlantic Salmon at the Ganaraska River fishway at Port Hope, Ontario from March 26th to November 22nd, 2018.

1.5 Credit River Fishway Migratory Salmon and Trout Assessment

M. J. Yuille, Lake Ontario Management Unit

The Credit River, below the Kraft Dam in Streetsville, has been the long-term sampling site for Chinook Salmon gamete collection. The Lake Ontario Management Unit completed infrastructure upgrades and construction on the Streetsville Fishway and installed the second Riverwatcher Fish Counting System in August 2018. The Credit River Riverwatcher was operational August 14, 2018 and continued to collect data through to November 15, 2018. This marks a key milestone for not only the Ministry that now owns and operates the only Riverwatcher systems in the province (see also Section 1.4), but also for the Atlantic Salmon Restoration Program, where adult assessment is the focus of the current Five Year Implementation Strategy (see Section 8.2). This section includes a summary of the Credit River Riverwatcher data (available at: www.riverwatcherdaily.is/frontpage.aspx?CtrID=143&A=1) as well as the annual Credit River Chinook Salmon Spawning Index.

Credit River Riverwatcher

The Credit River Riverwatcher (Fig. 1.5.1) was installed at the exit of the Streetsville Fishway August 14th, 2018. This fish counter technology (known as the Riverwatcher) automatically counts fish as they pass through the counting tunnel and records both a silhouette image and short, high resolution video for each individual fish (see Section 1.4). After installation, data were uploaded to the Riverwatcher Daily website every hour until the system was removed from the river on November 15th, 2018. In this time, a total of 1,968 fish were observed moving upstream through the Streetsville Fishway (Fig. 1.5.2). The total count is the number of fish that passed through the counter under a selective passage experiment.

Starting September 20, 2018 OMNRF Aurora District initiated experimental trials manipulating jump height (i.e., increasing jump height) within the Streetsville Fishway to facilitate the passage of Atlantic Salmon, while restricting access to Pacific Salmonid species (i.e., Chinook Salmon and Coho Salmon). It is unknown if increasing the jump height in the fishway is an effective method of selectively passing Atlantic Salmon, while reducing passage of other salmonid species. There are many factors, in addition to jump height, that contribute to fish passage efficiency, such as river flow, turbidity, temperature, individual species characteristics (e.g., body size and jump potential) and species interactions (i.e., fish behavior, crowding in jump

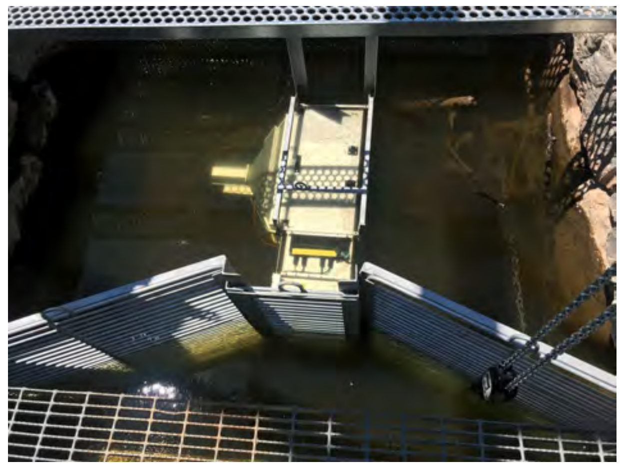


FIG. 1.5.1: VAKI Riverwatcher fish counter and frame custom designed for the Streetsville Fishway, Credit River, Mississauga, Ontario.

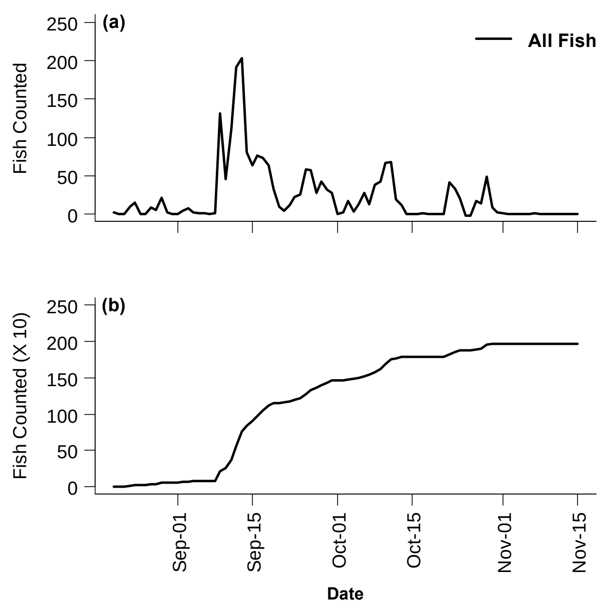


FIG 1.5.2: (a) Daily and (b) cumulative observed fish counts at the Streetsville Fishway, Credit River, Mississauga, Ontario from August 14th to November 15th, 2018.

pools, etc.). As a result, the effects of the jump height manipulation experiment on each migratory salmon and trout species are unknown; what is known is that access upstream of the Reid Mill Dam via the Streetsville Fishway was significantly reduced overall. The Riverwatcher fish counter remained active and operational throughout these experimental trials to document successful passages of migratory salmon and trout.

Additionally, during periods of heavy rainfall river flows increased, making the water cloudy. As the water became less clear, the light from the infrared counting sensors could not penetrate through the water, thus fish could not be counted. During these periods of high flow and turbid water, we did not have the capacity to count fish as they moved through the fishway. There were occasions throughout the monitoring period where the volume of fish moving through the fish counter exceeded the system's ability to count them individually. Calibration of each fish counting system is tailored to the specific installation site using manual hand counts. The calibration of both the Credit River and Ganaraska River fish counters is ongoing and will aide in providing estimates of fish missed during periods of high turbidity and high fish volume.

September 13th, 2018 marked the most active day on the fishway with a total of 203 salmon and trout observed migrating upstream through the Riverwatcher (Fig. 1.5.3). Throughout the monitoring period, data on Rainbow Trout, Chinook Salmon, Coho Salmon, Brown Trout and Atlantic Salmon were collected. The following paragraphs provide species specific observations.

Rainbow Trout

A total of 14 Rainbow Trout were identified migrating upstream through the Streetsville Fishway from August 14th to November 15th, 2018 (Fig. 1.5.4). The Riverwatcher fish counter was not operational in the spring, so total numbers migrating through the fishway in 2018 are not available. The Lake Ontario Management Unit is planning on monitoring the Streetsville Fishway throughout the 2019 season (spring, summer and fall).

Chinook Salmon

A total of 1,390 Chinook Salmon were identified migrating upstream through the Riverwatcher in 2018. The first Chinook Salmon was observed August 20th, 2018 and the last observed on October 30th, 2018 (Fig. 1.5.5). For more detailed information on Chinook Salmon, please see Credit River Chinook Salmon Spawning Index (below).

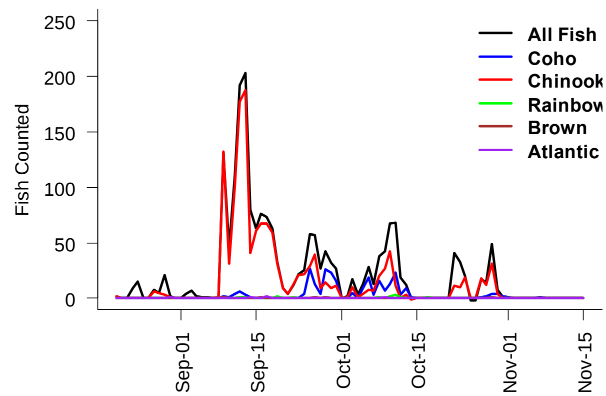


FIG. 1.5.3. Daily counts of each species of salmon and trout observed migrating through the Streetsville Fishway, Credit River, Mississauga, Ontario from August 14th to November 15th, 2018.

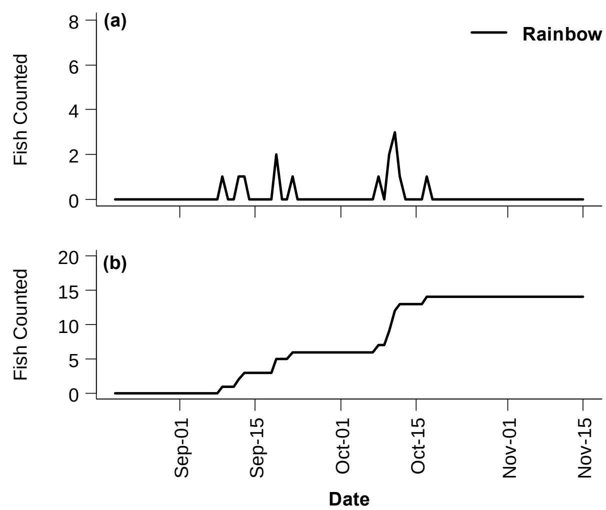


FIG. 1.5.4. (a) Daily and (b) cumulative observed counts of Rainbow Trout at the Streetsville Fishway, Credit River, Mississauga, Ontario from August 14th to November 15th, 2018.

Coho Salmon

The first Coho Salmon observed at the Streetsville Fishway in 2018 was on September 9th. A total of 253 Coho Salmon were identified exiting the Streetsville Fishway (Fig. 1.5.6). The last Coho Salmon observed moving through Streetsville Fishway was on November 7th, 2018. There were two main pulses of Coho Salmon, occurring over a few days in late September and early October (Fig. 1.5.6).

Brown Trout

The first Brown Trout observed at the Streetsville Fishway in 2018 was on September 9th. A total of five Brown Trout were identified exiting the Streetsville Fishway (Fig. 1.5.7). The last Brown Trout observed was on October 29th, 2018.

Atlantic Salmon

The first Atlantic Salmon observed at the Streetsville Fishway in 2018 was on August 30th. A total of five Atlantic Salmon were identified exiting the Streetsville Fishway (Fig. 1.5.8). The last Atlantic Salmon observed on the fish counter was on October 9th, 2018.

Credit River Chinook Salmon Spawning Index

Each year, Chinook Salmon are captured during the fall spawning run on the Credit River, below Streetsville Dam, at the beginning of October using electrofishing gear for gamete collections. LOMU staff have utilized the fish collections to index growth, condition and lamprey marking of Chinook Salmon.

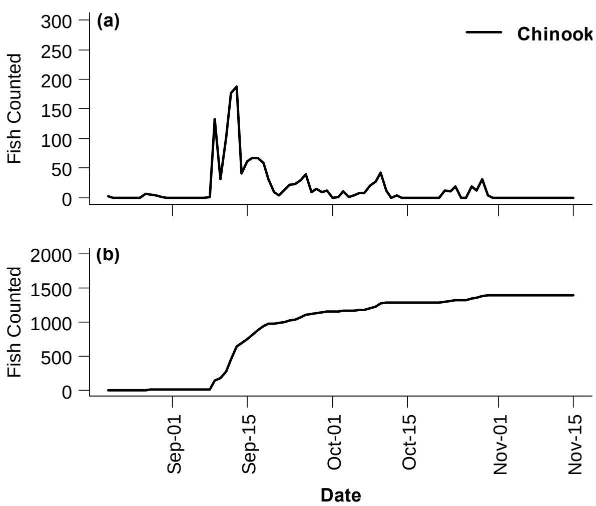


FIG .1.5.5. (a) Daily and (b) cumulative observed counts of Chinook Salmon at the Streetsville Fishway, Credit River, Mississauga, Ontario from August 14th to November 15th, 2018.

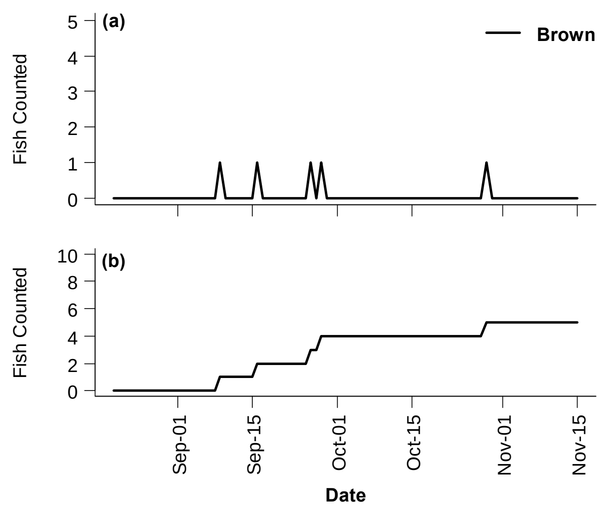


FIG. 1.5.7. (a) Daily and (b) cumulative observed counts of Brown Trout at the Streetsville Fishway, Credit River, Mississauga, Ontario from August 14th to November 15th, 2018.

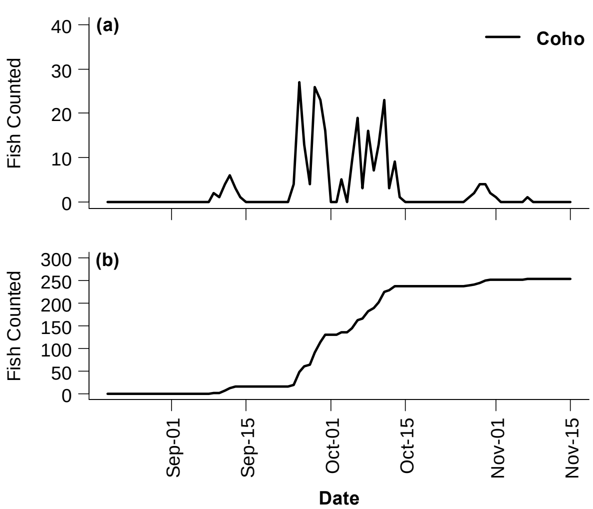


FIG. 1.5.6. (a) Daily and (b) cumulative observed counts of Coho Salmon at the Streetsville Fishway, Credit River, Mississauga, Ontario from August 14th to November 15th, 2018.

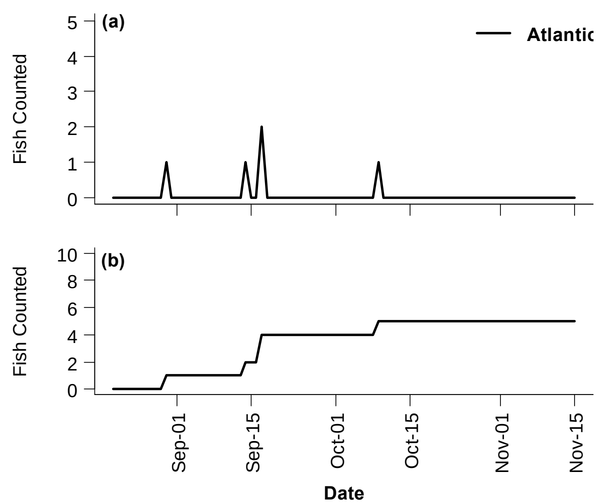


FIG. 1.5.8. (a) Daily and (b) cumulative observed counts of Atlantic Salmon at the Streetsville Fishway, Credit River, Mississauga, Ontario from August 14th to November 15th, 2018.

Weight and otoliths are collected from fish used in the spawn collection, which has the potential to be biased toward larger fish. To obtain a representative length sample of the spawning run, 50 fish per day were randomly selected, measured and check for clips prior to fish being sorted for spawn collection and detailed sampling. Detailed sampling included collecting data on length, weight, fin clips, coded-wire tag (CWT), lamprey marks and a subsample also had otoliths collected for age determination.

Samples for the 2018 Chinook Salmon index were taken between October 3rd – 19th. Lengths were taken on a total of 1,040 Chinook Salmon 413 randomly selected fish (non-detailed sampling) and 627 fish where detailed sampling occurred. Of the randomly selected fish, 14.5% were observed with an adipose clip. To increase the diversity of the Chinook Salmon egg collection, LOMU began collecting Chinook Salmon eggs and milt from the Ganaraska River in addition to the Credit River. Fish that were stocked into the Credit River that were collected from the Ganaraska River had their adipose removed prior to stocking. This allows LOMU staff to identify the stock origin (Credit River/ Wild = adipose fin intact; Ganaraska = adipose removed/clip) of the mature Chinook Salmon in the Credit River during the spawn/egg collection. Stocking of Ganaraska River Chinook Salmon into the Credit River began in 2015, so fish observed with an adipose clip would be from the 2016 and 2017 stocking events (see Section 6.1). Of the 60 fish observed with an adipose clip, 40 were male and 20 were female. Of the males 92.5% were age-2 (from the 2016 stocking event) and the remaining were age-1 (from the 2017 stocking event). Of the female fish, all 20 were age-2 (from the 2016 stocking event). In 2018, 62% of the spawning population (clipped and unclipped) were two years old (highest 2-year old proportion in the time series), 34% were age 3 (Fig. 1.5.9).

In 2018, average fork length of Chinook Salmon at age-2 and age-3 decreased for both males and females (Fig. 1.5.10). The average fork length of age-3 males (867 mm) decreased from 2017 and is 2% below the long-term average of 885 mm. Average length of age-3 females (845 mm) declined from 2017 and is 3% below the long-term mean (872 mm; Fig. 1.5.10). Length of age-2 females (764 mm) and males (785 mm) decreased from 2017 and are 5% and 1% (respectively) below the long-term averages (Fig. 1.5.10).

The estimated weight (based on a log-log regression) of a 914 mm / 36" (total length) Chinook Salmon is used as an index of condition. In 2018, female condition was lower than 2017; its first decline since 2015 (Fig. 1.5.11). A sharp decline in male condition was observed in 2018 as well (Fig. 1.5.11). Female condition in 2018 (7,209 g) is the lowest in the 29 year time series; an 8% decline from the previous 10 year average (7,807 g). Male condition (6,832 g) in 2018 is 8% below the average condition over the past 10 years (7,420 g) and has declined 14% since its peak in 2016. It should be noted that the absolute difference between maximum and minimum condition for female (1995 and 2018) and male (1995 and 2018) Chinook Salmon in this time series is 1,605 g and 1,156 g (respectively).

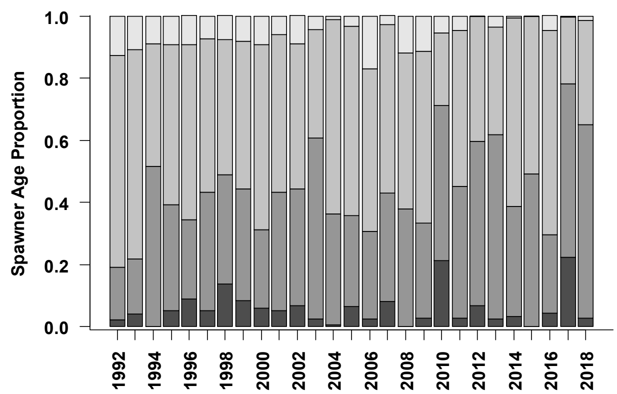


FIG. 1.5.9. Age proportions of spawning Chinook Salmon (males and females pooled) sampled during the fall Credit River Chinook Salmon Spawning Index, Credit River, Mississauga, Ontario from 1992 – 2018. The four grey colours correspond to each age where Age 1 is the darkest and Age 4 is the lightest.

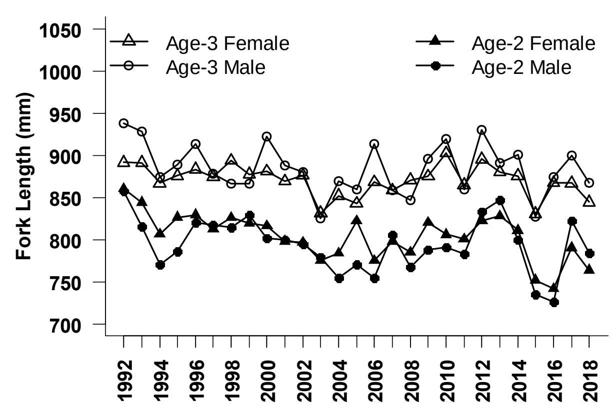


FIG. 1.5.10. Mean total length of age-2 and age-3 Chinook Salmon by sex, caught for spawn collection in the Credit River during the fall spawning run (approximately first week of October), 1989-2018.

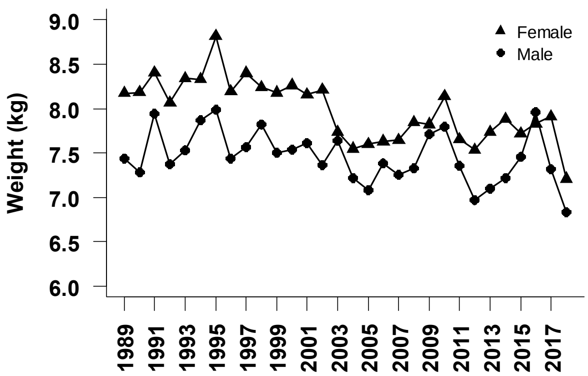


FIG. 1.5.11. Condition index as the mean weight of a 914 mm / 36 inch (total length) Chinook Salmon in the Credit River during the spawning run (approximately first week of October), 1989-2018.

1.6 Lake Ontario Summer Pelagic Prey Fish Survey

J. P. Holden, Lake Ontario Management Unit
M. J. Connerton, Cape Vincent Fisheries Station, NYSDEC
B. C. Weidel, Lake Ontario Biological Station, USGS
C. W. Elliott, Queen's University

Hydroacoustic surveys use scientific echosounders based on the same technology as recreational fishing sonars (a.k.a. depth finders) to assess fish populations (Fig. 1.6.1). Scientific echosounders collect, store and allow users to post process the data to obtain fisheries population estimates. Hydroacoustic assessments of Lake Ontario prey fish have been jointly conducted by the Ontario Ministry of Natural Resources and Forestry (OMNRF), the New York State Department of Environmental Conservation (NYSDEC) and the U.S. Geological Survey (USGS) to provide lake-wide indices of abundance for prey fish species. The data has also been used to provide abundance estimates of Mysis, a small shrimp-like invertebrate that is an important prey item for prey fish. The primary survey is done at night and consists of cross lake transects with an additional transect through the Kingston Basin (Fig. 1.6.2). Recent years have included more nearshore area to inform the spatial distribution of Cisco and Bloater (Figure 1.6.3). In 2018, a second, reduced survey was conducted in September as part of the Cooperative Science and Monitoring Initiative (Section 10.1).

Midwater trawling (see Table 1.6.1 for gear design) is conducted throughout the survey to inform apportionment of generalized abundance estimates obtained from hydroacoustics to species

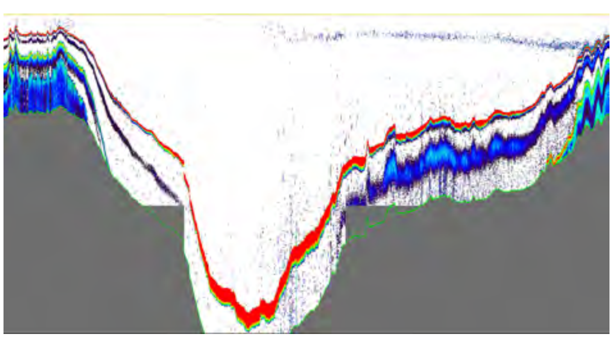


FIG. 1.6.1. An echogram collected on July 24th, 2018 from near Oak Orchard (left) to Cobourg (right). The echogram resembles recreational sonars but allows fine scale control of the settings; data logging; and the ability to post process the data to obtain estimates of fish abundance. The majority of the fish observed on this transect were on the Canadian side and in the upper portion of the water column.

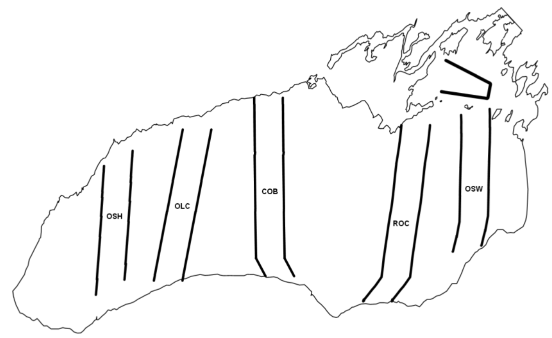


FIG. 1.6.2. The Lake Ontario Lake-wide pelagic prey fish survey uses cross-lake hydroacoustic transects. Transect corridors are logistically constrained by suitable ports but utilize a random starting point within the corridor for each annual survey

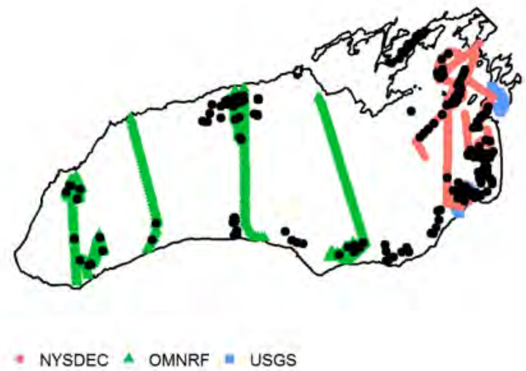


FIG. 1.6.3. Spatial coverage of the hydroacoustic data collection for July 2018 by OMNRF, NYSDEC and USGS. Cross-lake transects are supplemented with additional nearshore transects that include midwater trawls (indicated by solid dot).

TABLE 1.6.1. Description of midwater trawl.

Component	Description
Vessel Tow Speed	3 - 3.5 kts
Headrope length	18.3m
Footrope length	18.3m
Front Mesh	101 mm
Cod End	12.7 mm
Wing Spread	7 m
Net Height	6 m
Door Area	1.25 m^2
Note	22.5 kg of weight were hung from each wing to spread the trawl

specific abundance. Midwater trawling included 57 tows in July, 20 tows in September plus an additional six tows in the lower Bay of Quinte during September. A total of 18 species were captured in the midwater trawls (Table 1.6.2) eight of which were captured only in the Bay of Quinte. Lake catches were numerically dominated by Alewife and Rainbow Smelt in both seasons. When ranked according to biomass (kg), Cisco were the second most abundant species in July (after Alewife) and the most abundant in both regions in September. Also, of note, four juvenile Chinook Salmon (1 in July, 3 in September) were caught in tows near Cobourg (presumed age-0).

Historical midwater trawling data (2000 to 2004) showed a thermal separation between the two primary species of interest, Alewife and Rainbow Smelt. Midwater tows in depths where water temperatures were 9°C or warmer were dominated by catches of Alewife (95% total catch weight of prey fish species) whereas tows in depths at temperatures below 9°C captured mostly Rainbow Smelt (84%). This thermal separation of the two dominant species coupled with target strength threshold ranges consistent with prey fish species has been used as a means of species apportionment throughout the period when mid-water trawling was not conducted. Midwater trawl data from July 2018 provides additional evidence for this approach as Alewife catches show a strong relationship with temperature and decline to low catch numbers below 10°C (Fig. 1.6.4).

TABLE 1.6.2. Summary of catch data for all species captured in mid -water trawls.

	Number Caught			Biomass (kg) Caught		
	July	Sept	Sept - BQ	July	Sept	Sept - BQ
Alewife	4906	691	562	121.09	9.56	3.04
American eel	0	0	2	0.00	0.00	1.39
Bluegill	0	0	1	0.00	0.00	0.00
Chinook salmon	1	4	0	0.06	9.39	0.00
Cisco (lake herring)	99	48	15	32.78	19.24	6.13
Common shiner	0	0	1	0.00	0.00	0.01
Deepwater sculpin	1	0	0	0.00	0.00	0.00
Gizzard shad	0	0	259	0.00	0.00	6.16
Lake trout	0	1	3	0.00	8.35	2.80
Lake whitefish	1	0	0	1.29	0.00	0.00
Rainbow smelt	218	2349	314	2.14	15.50	2.69
Round goby	2	1	16	0.00	0.00	0.02
Slimy sculpin	2	0	0	0.02	0.00	0.00
Threespine stickleback	0	2	0	0.00	0.00	0.00
Trout-perch	0	0	109	0.00	0.00	1.37
Walleye	0	0	5	0.00	0.00	4.01
White perch	0	0	3	0.00	0.00	0.12
Yellow perch	0	0	8	0.00	0.00	0.07

The index of Alewife age-1 and older trend from hydroacoustic data was based on a minimum data threshold (-50 dB) from a theoretical relationship between the length of the fish and it's resulting target strength. The threshold was intended to exclude age-0 fish from the population estimate. A comparison between Alewife target strengths distributions suggest that age-0 fish peak below -60 dB in July and that the peak has shifted above -60 dB by September (Fig. 1.6.5) when age-0 Alewife are caught in midwater trawls (Fig. 1.6.6). An analysis of Alewife behaviour using a stationary, submersed surface looking transducer determined that a single fish could exhibit a wide range of target strength depending on whether the fish was oriented horizontally or in a diving position. Fish behaviour was also analyzed by looking at fish tracks (multiple pings on a single fish) from the mobile survey data that indicated a diving response of fish near the surface which would result in a fish having a lower target strength than the fish length would predict. These combined results supported re-analyzing historical data with a lower minimum threshold (-60 dB) than previously applied (-50 dB for Alewife, -52 dBfor Rainbow Smelt). Analysis parameters for hydroacoustic data analysis are available in Table 1.6.3. The general trend of abundance remains consistent with past surveys although population estimates have increased. The 2016 survey estimate increases more than other years, possibly indicating faster growth of age-0 fish early in the season to reach the minimum target strength

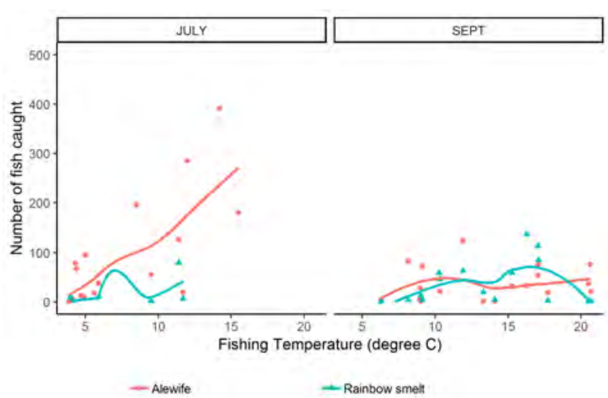


FIG. 1.6.4. Temperature effect on midwater trawl catches of Alewife and Rainbow Smelt in July and September 2018. Trend line is a loess fit.

threshold by July; however, this hypothesis requires further investigation.

The age-1 and older Alewife index for 2018 is 1.97 billion fish down from 4.48 billion fish in 2017. Midwater trawl catches indicate a large proportion of age-2 fish (120 to 150 mm) (Fig. 1.6.6). Distribution across the lake differs (Fig. 1.6.8) significantly from the pattern observed in the Spring (Fig. 7.8.3). During July, Alewife tend to be much more dispersed in relation to warm water. At the time the survey was conducted there was a significant upwelling event along the south east shore and lower density of Alewife in these areas. Few Alewife were caught in trawls at these areas at that time (Fig. 1.6.9). In years where midwater trawling was conducted concurrently with the hydroacoustic transects the whole lake numeric index was converted to a biomass estimates (Table 1.6.4) using mean Alewife weight obtained from the trawls to provide a comparable index to bottom trawl surveys (Table 7.8.1) and other lakes.

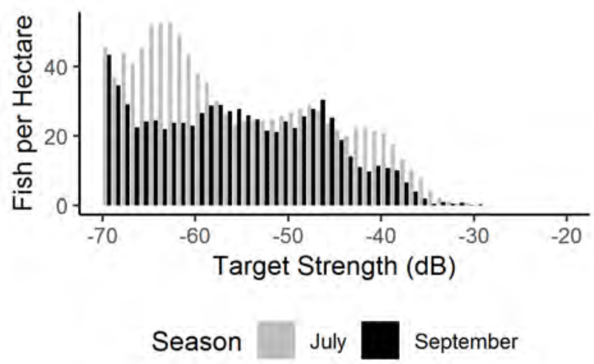


FIG. 1.6.5. Differences in target strength (acoustic measure of fish size) distribution in July and September of the warmwater (≥10°C) layer occupied primarily by Alewife.

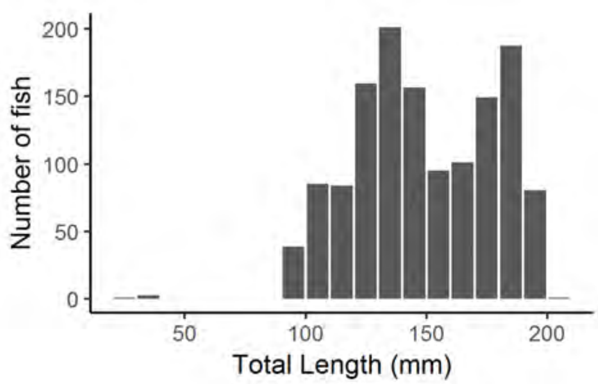


FIG. 1.6.6. Alewife size distribution in July midwater trawl catches.

TABLE 1.6.3. Acoustic parameter settings and target strength thresholds used for the 2018 survey.

Parameter	Specification
Sounder	BioSonics DT-X
Transducer Frequency	120 kHZ split beam
Ping Rate	1 ping per second
Maximum Beam Compensation	6 dB
Analytical Software	Echoview (version 8.0)
Target Strength (TS) Range	-60 to -39 dB
Sv Minimum TS threshold	-60 dB

TABLE 1.6.4. Alewife biomass estimates (kg/ha) from hydroacoustic data collected from cross lake survey transects in July

Year	Biomass (kg/ha)
2016	45.1
2017	47.7
2018	26.6

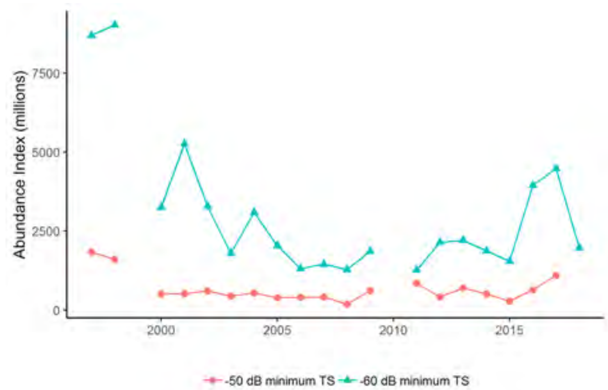


FIG. 1.6.7. Alewife abundance trend based on two different minimum thresholds. The historic index used a -50 dB minimum target strength threshold to define age-1 and older Alewife. Recent research suggests that in July a minimum threshold of -60dB targets are still age-1 Alewife. Past years have been re-analyzed using the lower threshold. Complete surveys were not conducted in 1999 or 2010.

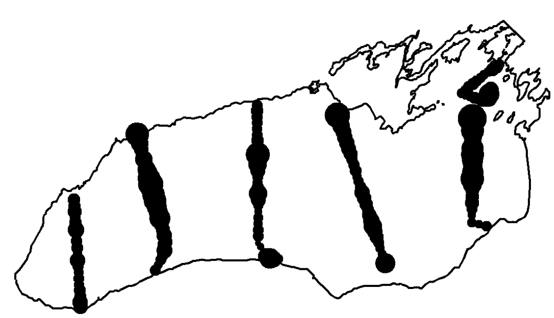


FIG. 1.6.8. Spatial distribution of Alewife in July. Points are scaled to relative density

The index of Rainbow Smelt abundance increased in 2018 to 99.7 million fish but remains well below population levels observed in the 1990s (Fig. 1.6.10). The areas of highest Rainbow Smelt density occurred in the eastern portion of the Lake. The Kingston Basin and the Stony Island area had unusually high numbers of Rainbow Smelt relative to other parts of the Lake (Fig. 1.6.11)

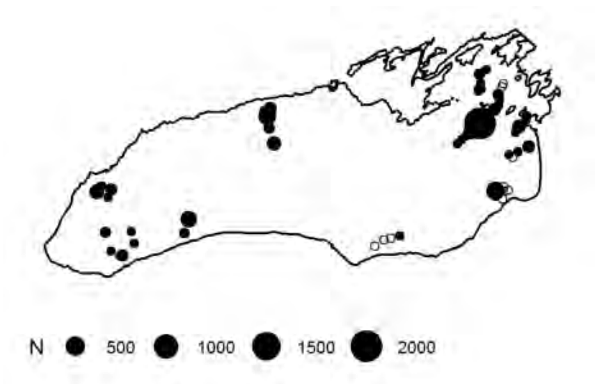


FIG. 1.6.9. Midwater trawl sites and catches of Alewife. Open circles are trawls that did not capture Alewife. Filled circles are scaled to catch.

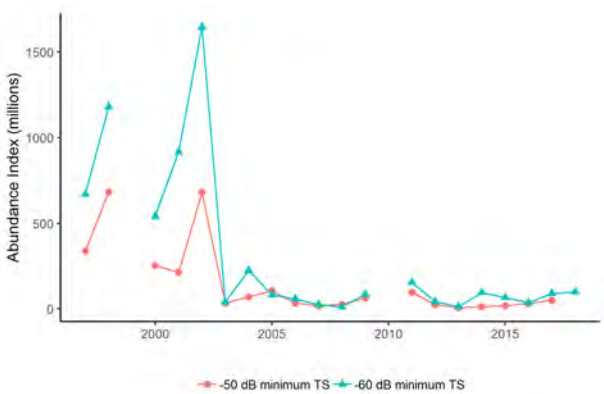


FIG. 1.6.10. Rainbow Smelt abundance trend based on two different minimum thresholds. The historic index used a -50 dB minimum target strength threshold to define age-1 and older Rainbow Smelt. Past years have been re-analyzed using the a lower -60 dB threshold. Complete surveys were not conducted in 1999 or 2010.

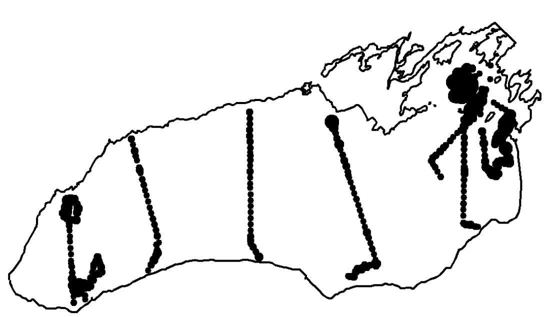


FIG. 1.6.11. Spatial distribution of Rainbow Smelt in July. Points are scaled to relative density.

Additional hydroacoustic data collected during September requires further analysis to produce late season population estimates and potentially requires a different analytical approach. Unlike July, where midwater trawls show thermal separation between Alewife and Smelt; fall catches exhibit greater mixing of the two species as Alewife tend to be more dispersed through the water column (Figure 1.6.12). As the thermocline becomes sharper (greater change in temperature over a smaller depth gradient) towing the midwater trawl through a target temperature becomes difficult due to the height of the trawl. Differences of over 10°C between the footrope and headline temperature have regularly been observed (Fig.1.6.13). A preliminary analysis of the hydroacoustic data from the Bay of Quinte shows a much higher fish density than the Kingston Basin and the main lake. Further analysis is required to account for the greater species diversity observed in the midwater trawls.

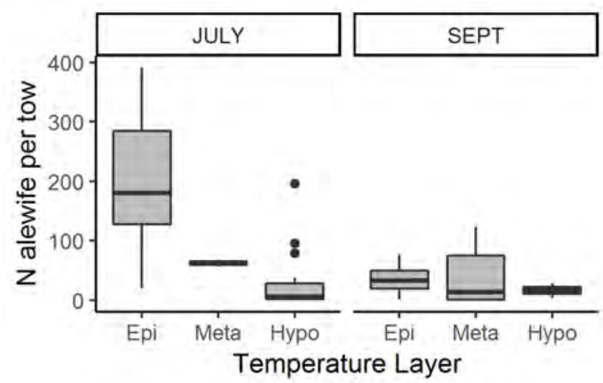


FIG. 1.6.12. Midwater trawl catches of Alewife within temperature layers in the water column. Catches in the epilimnion (Epi) were defined as having both the headrope and footrope in temperatures ≥ 10°C; hypoliminion (Hypo) where both are < 10°C and metalimnion (Meta) where the headrope was ≥ 10°C and the footrope was < 10°C.

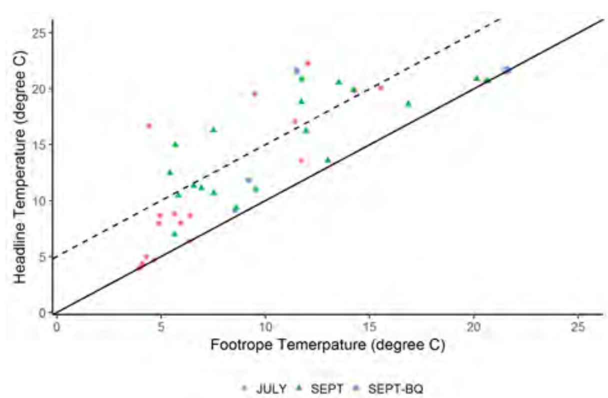


FIG. 1.6.13. Relationship between headline and footrope temperatures. Solid line indicates the 1:1 line. Dotted line indicates a headline temperature 5°C greater than the footrope temperature.

1.7 Lake Ontario Spring Prey Fish Assessment

J. P. Holden, Lake Ontario Management Unit
M. J. Connerton, Cape Vincent Fisheries Station, NYSDEC
B. C. Weidel, Lake Ontario Biological Station, USGS

Since 1978 the New York State Department of Environmental Conservation (NYSDEC) and the U.S. Geological Survey (USGS) have annually conducted 100 - 120 bottom trawl tows, primarily in US waters in early spring, to provide an index of Alewife abundance as well as biological attributes such as age distribution and body condition. As the dominant prey species in Lake Ontario, understanding Alewife abundance and age structure is important for assessing predator/prey balance and establishing safe stocking levels of predator species (i.e. Chinook Salmon, Lake Trout).

Since 2016, the survey has been expanded to Canadian waters with the Ontario Ministry of Natural Resources and Forestry (OMNRF) trawling a portion of the Canadian sites (Fig. 1.7.1). In 2018, a total of 208 sites were conducted, sampling depths from 5 - 218 m between April 9th and May 3rd.

The survey generally samples depths in proportion to the lake area however there are differences in how those samples are distributed between jurisdictions. The south shore has well distributed coverage as most depths between 8 - 200 m can be surveyed at each transect. Bottom trawling along the north shore is less uniform due to a lack of suitable trawl sites at shallower depths. Attempts to trawl at depths shallower than 80 m in the main basin have consistently resulted in snags and torn trawl nets. During the day, in early spring, most Lake Ontario Alewife are found near the lake bottom in the warmer, deeper water (75 m – 150 m) thus trawl sites at depths greater than 80m provide suitable index sites for Alewife. Additionally, shallow tows (<40m) in

FIG. 1.7.1. Geographic distribution of trawl sites conducted by OMNRF, USGS and NYSDEC during the 2018 Lake Ontario Spring Prey Fish Assessment.

Ontario waters occur disproportionately in the Kingston Basin. Efforts continue to identify suitable trawl locations along the north shore portion of the main Lake.

All vessels followed a standard trawl protocol that utilized a polypropylene mesh bottom trawl referred to as “3N1” (see Table 1.8.1 for trawl dimensions) equipped with rubber discs that elevate the footrope off bottom to minimize catches of Dreissenid mussels. NYSDEC and USGS vessels used USA Jet slotted, metal, cambered trawl doors (1.22 m x 0.75 m) while OMNRF used comparable Thyborne doors to spread the trawl. Trawl mensuration gear was used to record door spread, bottom time and headrope depth. The general protocol is to tow a site for 5 min although actual bottom contact time varies with depth and vessel. Catches are adjusted to account for the actual area swept.

Sites were further expanded in 2018 to incorporate sampling more embayments habitat, including locations within the Bay of Quinte. The survey captured 384,651 individuals from 31 species. Alewife were 80% of the total catch by number and Round Goby, Deepwater Sculpin, and Rainbow Smelt comprised 12, 4, and 3% of the catch, respectively. Detailed results are provided in the Status of Prey Fish (Section 7.8).

TABLE 1.7.1. Gear specifications for the polypropylene mesh bottom trawl referred to as “3N1” and equipped with rubber discs that elevate the footrope off bottom to minimize catches of Dreissenid mussels.

Component	Description
Headrope length	20 m
Footrope length	22 m
Codend mesh	15.2 mm knotless nylon
Gear height	3.5 m
Fishing width	7 m
Cookie sweep description	Composed of 100 mm diameter rubber discs that sit 0.3 m below the footrope
Door weight	125 kg
Door area	0.93 m^2
Door height	1.2 m

1.8 Lake Ontario Fall Benthic Prey Fish Assessment

J. P. Holden, Lake Ontario Management Unit
M. J. Connerton, Cape Vincent Fisheries Station, NYSDEC
B. C. Weidel, Lake Ontario Biological Station, USGS

The Lake Ontario offshore prey fish community was once a diverse mix of pelagic and benthic fishes but by the 1970s the only native fish species that remained abundant was Slimy Sculpin. Recent invasions of Dressenid mussels and Round Goby have further changed the offshore fish community. The Lake Ontario Fall Benthic Prey Fish Assessment provides an index of how prey fish abundance, distribution and species composition has adapted through time in response to environmental change and species invasions.

A benthic prey fish assessment in the main basin of Lake Ontario has historically only been conducted by the U.S. Geological Survey (USGS). The survey assessed prey fish along six southern-shore, US transects in depths from 8 - 150 m. However, the restricted geographic and depth coverage prevented this survey from adequately informing important benthic prey fish dynamics at a whole-lake scale, including monitoring the reappearance of Deepwater Sculpin. In 2015, this program was expanded to include additional trawl sites conducted by OMNRF and New York Department of Environmental Conservation (NYSDEC).

The 2018 survey consisted of 119 trawls conducted from September 27th through November 1st throughout the entire lake (Fig. 1.8.1). Inclement weather and vessel repairs reduced the number of sites conducted in Canadian waters. The survey generally samples depths in proportion to the lake area however there are differences in how those samples are distributed between jurisdictions. Shallow tows (< 40m) in Ontario waters are largely confined to the Kingston Basin. Efforts continue to find suitable trawl locations in shallow waters along

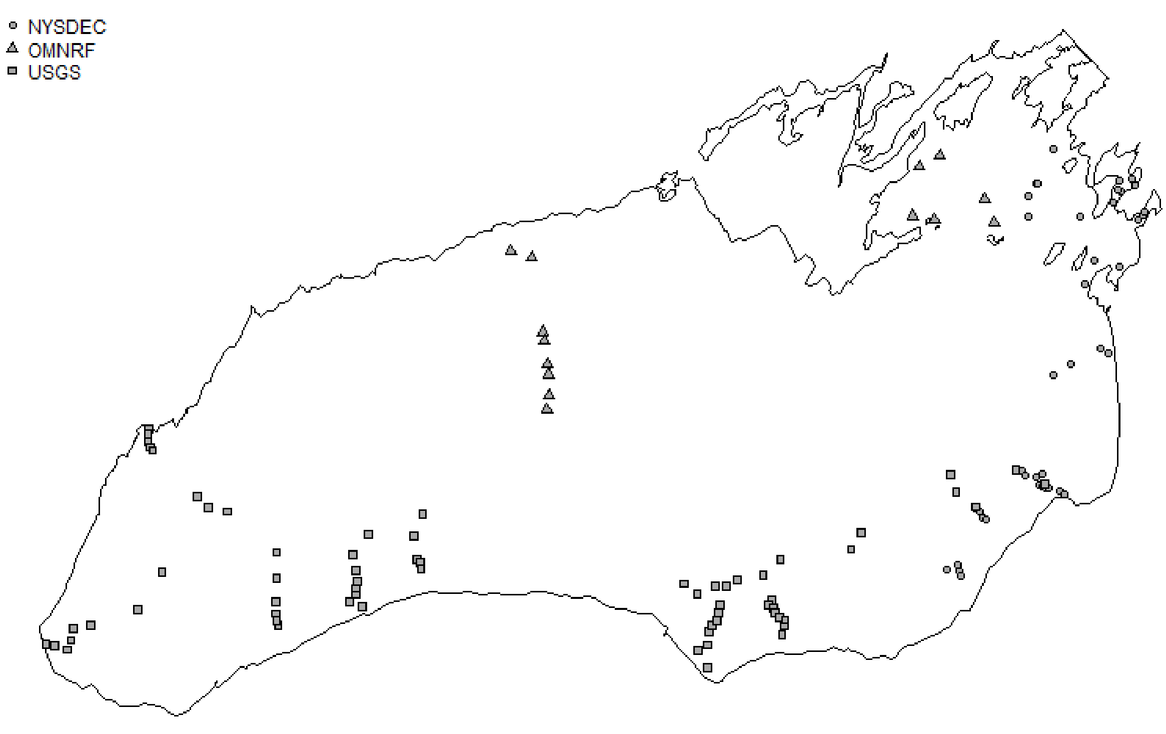


FIG. 1.8.1. Geographic distribution of trawl sites conducted by OMNRF, USGS and NYSDEC, 2018

the north shore portion of the main lake to improve the spatial coverage of this survey.

All vessels used a similar trawl (3/4 Yankee Standard, See Table 1.2.1 for specifications) however, doors varied between vessels. Depth loggers and wing sensors were used on all trawls to provide estimates of true bottom time and net opening to standardize catches between vessels.

Round goby were the most abundant species caught (N = 39,603) followed by Alewife (N = 16,258), Deepwater Sculpin (N = 5,886) and Rainbow Smelt (N = 1,763). Abundance trends and community indices are presented in detail in the Status of Lake Ontario Prey Fish Section (7.8).

1.9 St. Lake St. Francis Community Index Gill Netting

L. Johnson and M. Yuille, Lake Ontario Management Unit

Every other year in early fall, the Lake Ontario Management Unit (LOMU) conducts an Fish Community Index Gill Netting survey in Lake St. Francis. The catches are used to estimate fish abundance and measure biological attributes. Structures and tissues are collected for age determination, stomach content analyses, contaminant analyses and pathological examinations. The survey is part of a larger effort to monitor changes in the fish communities in four distinct sections of the St. Lawrence River: Thousand Islands, Middle Corridor, Lake St. Lawrence and Lake St. Francis. This survey is coordinated with New York Department of Environmental Conservation (NYSDEC) to provide comprehensive assessment of fisheries resources in the upper St. Lawrence River.

In 2018, the survey was conducted during the period of September 10th to 21st. Thirty-six nets were deployed, using standard multi-panel gillnets with monofilament meshes ranging from 1 ½ to 6 inches at half-inch increments. The nets were fished for approximately 24 hours. All catches prior to 2002 were adjusted by a factor of 1.58 to be comparable to the new netting standard initiated in 2002. In total, 407 fish were caught, which included 14 different fish species (Table 1.9.1). The average number of fish per set was 11.30, down 26% from 2016. The number of fish per set continued to decline from the record high in 2008 and is below the 1984 – 2016 average for the survey and it is now the lowest in the time series (Fig. 1.9.1). The dominant species in the catch continues to be Yellow Perch (60% of the catch), followed by Rock Bass (15%; Fig. 1.9.2).

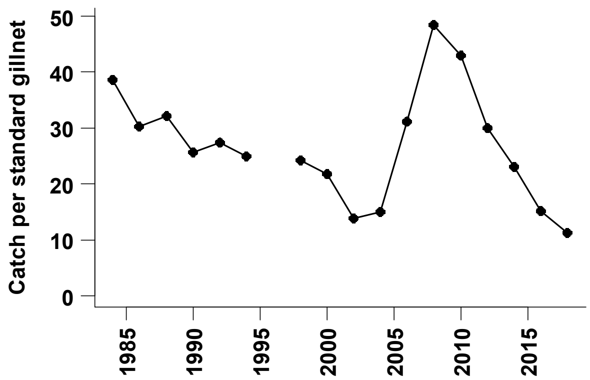


FIG. 1.9.1 Average catch per standard gillnet set of all species combined, Lake St. Francis, 1984 – 2018. Survey was not conducted in 1996.

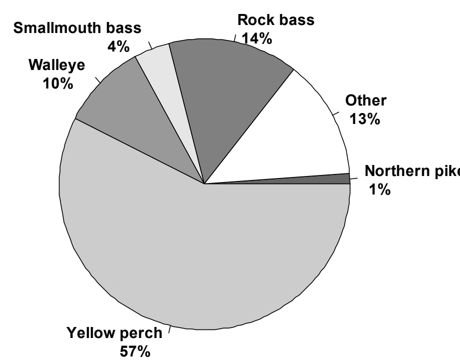


FIG. 1.9.2 Species composition in the 2018 Lake St. Francis community index gill netting program.

Species Highlights

Yellow Perch

Catches of Yellow Perch continued to decline from peak levels seen previously in 2008 and 2010 (Fig. 1.9.3). Current Yellow Perch catch per net (6.5 fish per net) is below the 1984 – 2016 survey average (15.97 fish per net; Table 1.9.1). An increase in the catch of large fish (> 220 mm) observed in 2008 and 2010 has been followed by continued decline in this group from 2012 to 2018 (Fig. 1.9.3). The catch per net of large fish in 2018 (0.62 fish per net) was the lowest observed in the time series (Fig. 1.9.3). Yellow Perch catch in 2018 contained fish from age-2 to age-8 with age-4 fish representing 42% of the total catch (Fig. 1.9.4).

Centrarchids

The centrarchids are represented by six species in Lake St. Francis: Rock Bass, Pumpkinseed, Bluegill, Smallmouth Bass, Largemouth Bass and Black Crappie (Fig. 1.9.5 and 1.9.6). While Rock Bass remain the most abundant of the centrarchids, catches in 2018 were 33% of the previous decade. Smallmouth

TABLE 1.9.1. Summary of catches per gillnet set in the Lake St. Francis Fish Community Index Gillnetting Program, 1984 - 2018. All catches prior to 2002 were adjusted by a factor of 1.58 to be comparable to the new netting standard initiated in 2002. No survey was conducted in 1996.

	1984	1986	1988	1990	1992	1994	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018
Lake Sturgeon	--	--	--	--	--	--	--	0.04	--	0.03	--	0.03	--	0.03	--	0.03	--
Longnose Gar	--	0.23	0.09	--	0.66	0.26	0.13	0.13	0.4	--	0.06	--	--	0.22	--	0.28	--
Bowfin	0.04	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alewife	0.04	--	--	--	--	--	--	--	0.03	0.06	0.22	--	--	0.14	0.03	--	--
Gizzard Shad	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.06	--
Salvelinus sp.	--	--	0.04	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Creek Chub	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Northern Pike	4.18	3.93	4.43	3.82	4.13	3.91	3.6	3.34	1.23	1.45	1.67	1.08	0.31	0.19	0.31	0.14	0.14
Muskellunge	--	--	0.04	--	--	--	--	--	--	0.03	--	--	--	--	0.03	--	--
White Sucker	1.71	2.17	1.01	1.71	1.4	1.67	1.93	1.62	0.74	1.06	0.97	1.97	1.56	1.17	1.25	0.56	0.47
Silver Redhorse	--	--	--	--	--	--	--	--	--	--	0.11	0.14	0.08	0.06	0.03	0.06	0.11
Shorthead Redhorse	--	--	--	--	--	--	--	--	--	--	--	--	--	0.28	0.06	0.03	0.03
Greater Redhorse	--	--	--	--	--	--	--	0.09	--	--	--	--	--	--	--	--	--
River Redhorse	--	--	--	--	--	--	0.18	--	--	--	--	--	0.06	--	--	--	--
Moxostoma sp.	--	--	0.04	0.18	0.04	0.09	--	--	--	--	--	0.06	--	--	--	--	0.11
Common Carp	0.13	--	--	0.09	--	--	--	--	0.09	--	0.25	0.03	--	--	--	--	--
Golden Shiner	--	--	--	--	--	0.04	--	--	0.03	--	--	--	--	--	--	0.06	0.22
Creek Chub	--	--	--	--	--	--	0.09	--	--	--	--	--	--	--	--	--	--
Fallfish	--	--	--	0.09	--	--	--	--	--	--	--	--	--	--	--	0.03	0.14
Brown Bullhead	1.14	1.27	0.61	0.4	0.7	0.44	0.92	3.25	0.54	1.38	2.81	1.97	0.56	0.25	0.14	0.03	--
White Perch	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.03	--
Rock Bass	3.52	3.48	2.81	1.36	2.15	2.11	2.5	1.84	2.25	2.17	5.69	7.83	7.03	3.94	2.97	2.72	1.64
Pumpkinseed	4.97	1.72	0.83	0.75	1.49	1.76	1.49	1.05	0.41	0.41	0.89	1.36	0.06	0.33	0.17	0.17	0.17
Bluegill	--	--	--	--	--	--	0.04	0.04	0.1	--	--	--	0.06	--	--	0.03	--
Smallmouth Bass	0.88	0.63	0.26	0.26	0.61	0.61	1.36	0.44	1.02	0.58	1.17	1.67	0.44	0.47	0.67	0.28	0.44
Largemouth Bass	0.04	--	0.09	0.09	--	0.04	0.09	0.13	0.2	--	0.61	0.31	0.33	1.53	--	0.69	0.22
Black Crappie	0.04	0.09	0.04	0.04	0.09	0.13	--	0.09	0.07	--	--	--	--	--	--	0.08	0.03
Yellow Perch	21.45	16.32	20.85	16.55	15.8	13.69	11.54	9.35	6.48	7.49	16.36	30.89	30.83	20.64	16.67	9.36	6.5
Walleye	0.48	0.45	0.97	0.35	0.35	0.26	0.35	0.31	0.16	0.41	0.39	1.08	1.58	0.78	0.81	0.47	1.08
Freshwater Drum	--	--	--	--	--	--	--	--	0.04	--	--	0.03	--	--	--	0.03	--
All Species	38.62	30.29	32.11	25.69	27.42	25.01	24.22	21.72	13.79	15.07	31.2	48.45	42.9	30.03	23.14	15.14	11.3
Count of Species	13	10	14	13	11	13	13	14	16	11	13	14	12	14	12	20	14

Bass catches increased in 2018 relative to the 2016 catch but are currently 38% below the previous 10-year average (Fig. 1.9.5) with the majority being age-3 and age-4 (Fig. 1.9.6). Pumpkinseed catches were unchanged from 2016 to 2018 (Fig. 1.9.7). Bluegill, Largemouth Bass and Black Crappie were historically at much lower levels than the former three species and remain so (Fig. 1.9.6). In 2018, Largemouth Bass catches were below the previous 10-year average (Fig. 1.9.7).

Northern Pike

In 2018, catches of Northern Pike were comparable to 2016. Northern Pike abundances have been in decline since the early 1990s and are currently at the lowest levels observed in the 34-year time series (Table 1.9.1). A total of five Northern Pike were caught in 2018, ranging in from age-4 to age-8 (Fig. 1.9.8). In 2018, there were no small (≤ 500 mm) Northern Pike caught (Fig. 1.9.9). No Muskellunge were caught in 2018.

Walleye

Walleye represented 10% of the total catch in 2018 with 39 individuals caught. The average catch per net was 1.08; an increase from 2016 and roughly 12% greater than the previous 10-year average. Catches of small fish (≤ 500 mm) and large (>500 mm) continue to remain almost equal (Fig. 1.9.10). Walleye ages ranged from 1 to 12 years of age with the majority being ages 3, 4 and 5 (Fig. 1.9.11).

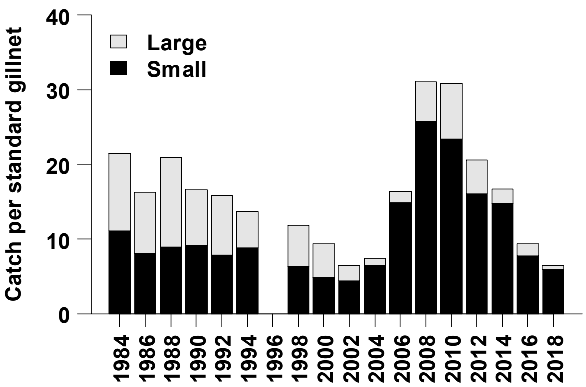


FIG. 1.9.3 Catches of small (≤ 220 mm total length) and large (> 220 mm total length) Yellow Perch in the Lake St. Francis community index netting program, 1984 – 2018. Survey was not conducted in 1996.

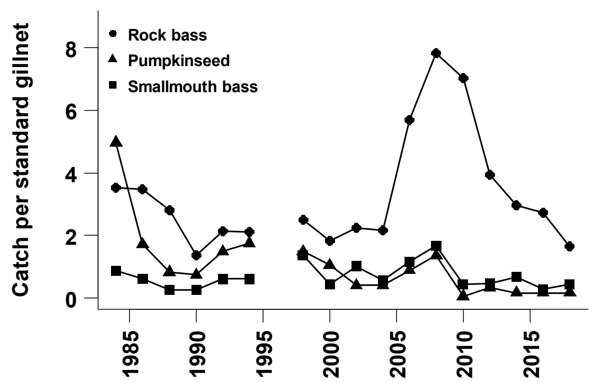


FIG. 1.9.5 Rock Bass (circle), Pumpkinseed (triangle) and Smallmouth Bass (square) catches per standard gillnet set in Lake St. Francis, 1984 - 2018.

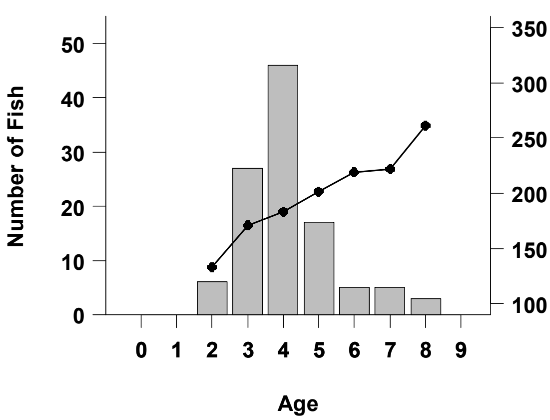


FIG. 1.9.4 Age distribution (bars) and mean fork length at age (mm) of Yellow Perch caught in Lake St. Francis, 2018.

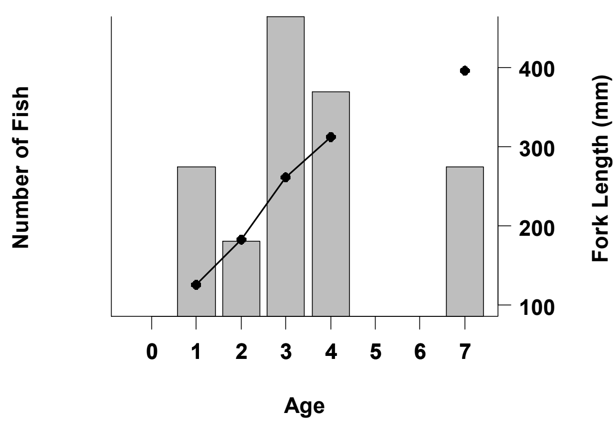


FIG. 1.9.6 Age distribution (bars) and mean fork length (circles) at age of Smallmouth Bass caught in Lake St. Francis, 2018.

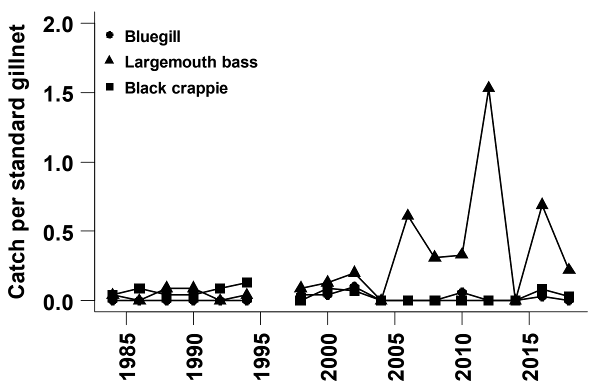


FIG. 1.9.7 Bluegill (circle), Largemouth Bass (triangle) and Black Crappie (square) catches per standard gillnet set in Lake St. Francis, 1984 – 2018.

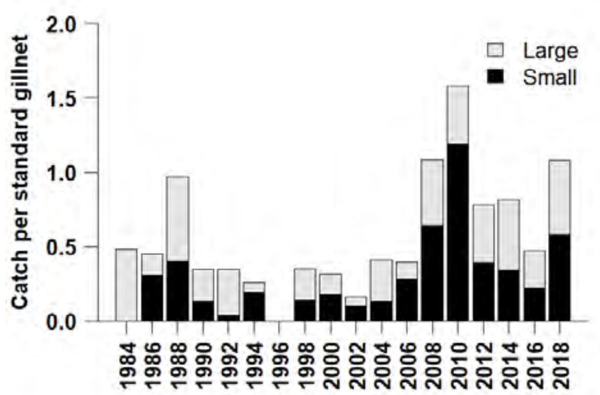


FIG. 1.9.10 Catches of small (≤ 500 mm total length) and large (> 500 mm total length) Walleye in the Lake St. Francis Community Index Gill Netting Program, 1984 – 2018. Survey was not conducted in 1996.

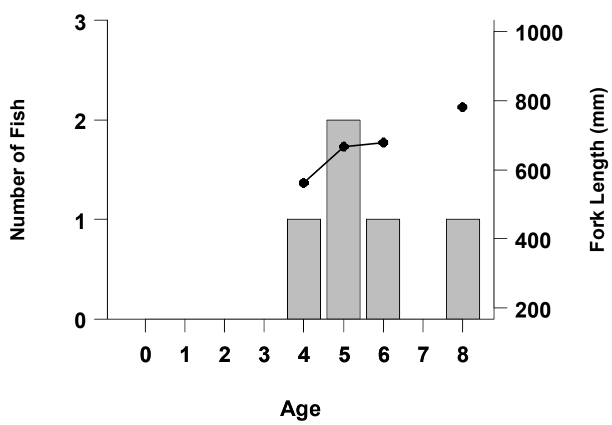


FIG. 1.9.8 Age distribution (bars) and mean fork length (circles) at age of Northern Pike caught in Lake St. Francis, 2018.

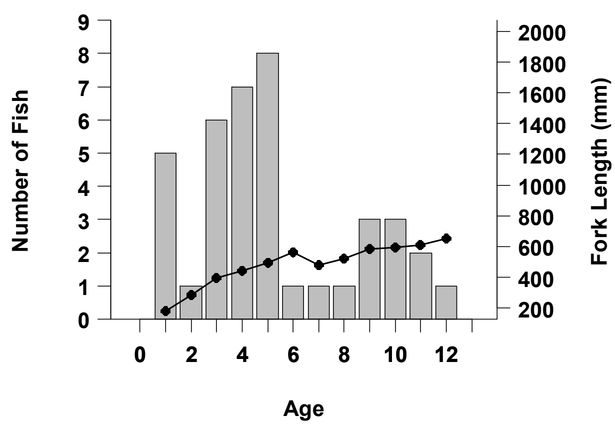


FIG. 1.9.11 Age distribution (bars) and mean fork length (circles) at age of Walleye caught in Lake St. Francis, 2018.

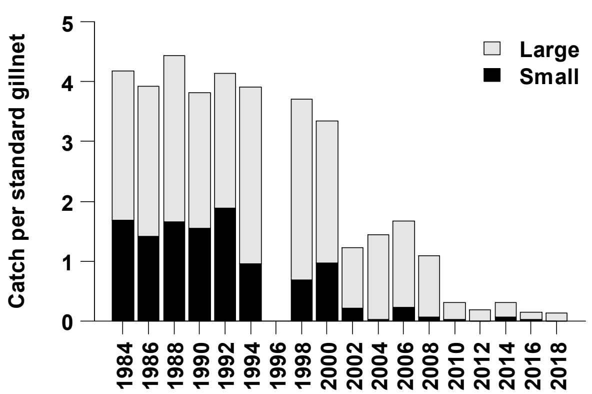


FIG. 1.9.9 Catches of small (≤ 500 mm total length) and large (> 500 mm total length) Northern Pike in the Lake St. Francis Community Index Gill Netting Program, 1984 – 2018. Survey was not conducted in 1996.

2. Recreational Fishery

2.1 Fisheries Management Zone 20 Council (FMZ20) / Volunteer Angling Clubs

C. Lake, Lake Ontario Management Unit

Fisheries Management Zone 20 (FMZ20) Council provides advice to the Lake Ontario Management Unit regarding the management of Lake Ontario recreational fisheries. The FMZ20 Council, established in 2008, has been instrumental in shaping the future of the Lake Ontario recreational fishery. Over the past decade the FMZ20 Council has been involved in renewing the Fish Community Objectives, developing a stocking plan, assisting with angler diaries, changing regulations to support sustainable harvest, growing the stocking net pen program, identifying issues and concerns and acting as liaison to improve broader pubic awareness about the fishery.

FMZ20 Council members represents a broad spectrum of interests across the zone including Muskies Canada, competitive bass anglers, Bay of Quinte and Upper St. Lawrence River Guides, Central Lake Ontario Sport Anglers, Metro East Anglers, Port Credit Salmon and Trout Association, Halton Region Salmon and Trout Association, St. Catharines Game and Fish Association, Ontario Sportfishing Guides Association, Ontario Commercial Fish Association, Ontario Federation of Anglers and Hunters, tributary anglers, academia, environmental interests and several unaffiliated anglers.

Over the past year the FMZ20 Council has been engaged in a binational fish stocking decision to address concerns about prey fish declines that could place the Chinook Salmon fishery at risk. Other topics the council discussed in 2018 included: adult Walleye harvest assessment in the Eastern basin of Lake Ontario, Largemouth and Smallmouth Bass angling seasons and rules for the number of fishing rods permitted.

Many of our volunteer clubs (council-affiliated and others) also help with the physical delivery of several management programs. Multiple clubs help with planning and implementation of Lake Ontario’s net pen rearing initiatives for Chinook Salmon (Section 6.2). Others help with the annual delivery of our stocking program through the operation of community-based hatcheries. The Napanee Rod and Gun Club helps MNRF meet its stocking targets by rearing Brown Trout. The Credit River Anglers stock Rainbow Trout and Coho Salmon. The Metro East Anglers, through their operation of the Ringwood hatchery, help the province meet its Rainbow Trout, Brown Trout, Atlantic Salmon, and Coho Salmon targets. Volunteers at the Ganaraska River-Corbett Dam Fishway assist MNRF staff install, maintain and operate the new fish counter. Numerous anglers and clubs also participate regularly by supplying catch and harvest information in our volunteer angler diary programs.

2.2 Lake St. Francis Recreational Fishery

M. J. Yuille, Lake Ontario Management Unit

The Ontario portion of Lake St. Francis is approximately 7,380 ha in size and is relatively shallow and eutrophic compared to the rest of the St. Lawrence River. These conditions are favourable for Yellow Perch production, the most popular species in the Lake St. Francis fishery.

The Yellow Perch fishery in Lake St. Francis is significant to the local area. Renowned for its abundance of "jumbo" perch, it was once the only area in Ontario where anglers were legally allowed to sell their catch. During the mid-1990s, concerns were raised about declines in Yellow Perch abundance, particularly large perch. With the goal of increasing Yellow Perch abundance, more restrictive angling regulations were put in place. These included changes in perch harvest and possession limits, a spring season closure (late-1990s) and prohibiting the sale of angler caught perch (2005).

Angling surveys have been conducted periodically over the years, on this important fishery. The 2018 survey replicated the design of the most recent surveys (2003, 2009 and 2013), beginning in May and consisting of three seasons: spring (May 5 to Jun 22), summer (Jun 23 to Sept 3) and fall (Sept 4 to Oct 5). The survey used both on-water boat counts and on-water angler interviews to determine angler activity and catch.

There were 1,831 anglers interviewed (1,069 boats) by field crews. Seventy percent of anglers interviewed were local, 14% were from Québec, 13% were from Ontario (but not local) and 4% were U.S. residents. Total angler effort was estimated to be 53,567 hours. Anglers reported catching 19 different species (Tables 2.2.1 and 2.2.2). Most angling effort was targeted toward Yellow Perch (24,005 hours) followed by Walleye (15,039 hours), Smallmouth Bass (9,439 hours) and Largemouth Bass (3,384 hours).

Anglers caught an estimated 175,103 Yellow Perch and harvested 79,691 (release rate 55%). Angling success was relatively high at 7.27 Yellow Perch caught (3.3 fish harvested) per hour of fishing. Anglers caught 6,874 and harvested 4,958 Walleye. Walleye catch rate was 0.455 fish per hour and release rate was 27%. Anglers also caught 8,523 Smallmouth Bass (0.845 fish per hour) and 2,001 Largemouth Bass (0.496 fish per hour).

As in previous surveys, angling effort has targeted mainly Yellow Perch (Tables 2.2.1, 2.2.2 and 2.2.3), however, angling effort targeting Yellow Perch has declined in proportion to the total effort in the fishery over the past 15 years (Table 2.2.3). Anglers caught an estimated 175,103 Yellow Perch and harvested 79,691 (release rate 55%). Angling success for Yellow Perch was the lowest in the four surveys (Table 2.2.1) but remains relatively high at 7.27 Yellow Perch caught (3.3 fish harvested) per hour of

TABLE 2.2.1. Species-specific statistics for open-water angling from May 5 to Oct. 5, 2018 on Lake St. Francis, St. Lawrence River. Shown are angling effort (for anglers targeting specific species), number of fish caught and harvested (by all anglers), percent of fish kept, and angling success (CUE; measured as the number of fish caught per hour for anglers targeting specific species). Total estimated angling effort was 53,567 hours; some anglers target more than one species, therefore the sum of species-specific targeted angling effort (63,818 hours) is greater than the actual total angling effort by all anglers.

Species	Angling Effort	Catch	Harvest	% kept	CUE
Lake Sturgeon	--	8	0	0	--
Bowfin	61	10	0	0	0.165
Rainbow Trout	--	26	0	0	--
Lake Herring	--	163	0	0	--
Northern Pike	4,465	1,444	245	17	0.275
Mukellunge	7,058	639	98	15	0.081
White Sucker	46	54	0	0	0.122
Fallfish	--	878	0	0	--
Brown Bullhead	27	71	0	0	--
Rock Bass	--	542	0	0	--
Bluegill	--	43	0	0	--
Smallmouth Bass	9,439	8,523	1,048	12	0.845
Largemouth Bass	3,384	2,001	263	13	0.496
Black Crappie	22	36	0	0	--
Sunfish	--	191	0	0	--
Yellow Perch	24,005	175,103	79,691	46	7.273
Walleye	15,039	6,874	4,958	72	0.455
Round Goby	271	4,413	113	3	--
Freshwater Drum	--	5	0	0	--
Total	63,818	201,024	86,416		

TABLE 2.2.2. Seasonal breakdown of selected creel survey statistics for open-water angling from May 5 to Oct. 5, 2018 on Lake St. Francis. Shown are "Spring" (May 5 to Jun 22; 49 days), "Summer" (Jun. 23 to Sept. 3, 2018; 73 days) and "Fall" (Sept. 4 to Oct. 5, 2018; 32 days), angling effort (both for all anglers and for anglers targeting specific species), number of fish caught and harvested (all anglers), angling success (measured as the number of fish caught per hour for anglers targeting a specific species) and the release rate (percent of fish released).

		Season			
	Species	Spring	Summer	Fall	Total
Angling Effort (angler hours):					
	Total all anglers	12,602	29,012	11,953	53,567
	Northern Pike	1,859	2,487	119	4,465
	Muskellunge	17	3,936	3,105	7,058
	Smallmouth Bass	205	6,400	2,834	9,439
	Largemouth Bass	246	2,829	309	3,384
	Yellow Perch	7,511	12,685	3,809	24,005
	Walleye	3,998	7,808	3,233	15,039
Number of fish caught (all anglers):					
	Northern Pike	900	454	89	1,444
	Muskellunge	57	212	370	639
	Smallmouth Bass	206	4,095	4,222	8,523
	Largemouth Bass	411	1,486	104	2,001
	Yellow Perch	61,312	84,035	29,755	175,103
	Walleye	2,103	3,405	1,366	6,874
Number of fish harvested (all anglers):					
	Northern Pike	226	19	0	245
	Muskellunge	--	0	98	98
	Smallmouth Bass	14	878	156	1,048
	Largemouth Bass	60	182	21	263
	Yellow Perch	31,355	33,497	14,838	79,690
	Walleye	1,356	2,584	1,018	4,958
Angling success (number of fish per hour):		0.30	0.12	0.30	0.28
	Muskellunge	--	0.08	0.12	0.08
	Smallmouth Bass	0.34	0.61	1.53	0.85
	Largemouth Bass	0.33	0.54	0.17	0.50
	Yellow Perch	7.62	4.96	5.82	7.27
	Walleye	0.34	0.56	0.34	0.46
Release rate (%):					
	Northern Pike	75	96	100	87
	Muskellunge	--	100	74	88
	Smallmouth Bass	93	79	96	82
	Largemouth Bass	85	88	80	81
	Yellow Perch	49	60	50	55
	Walleye	36	24	25	27

fishing. Anglers caught 6,874 and harvested 4,958 Walleye. Walleye catch rate was 0.455 fish per hour and release rate was 27%. Anglers also caught 8,523 Smallmouth Bass (0.845 fish per hour) and 2,001 Largemouth Bass (0.496 fish per hour). Effort and catch of Walleye and Smallmouth Bass in 2018 were comparable to the 2009 and 2013 surveys but represent a large increase in both statistics from the 2003 survey. This may indicate a shift in the Lake St. Francis fishery, with more angling effort being devoted to these species. More work is needed to understand the dynamic of the Lake St. Francis fishery in its current ecological state.

The average size of Yellow Perch harvested was 211 mm (Fig. 2.2.1) and the average age was 4.4 years (Fig. 2.2.2). Twenty-three percent of anglers indicated that the Yellow Perch fishery was unchanged (10%) or had improved (13%) in the last five years. Seventy-seven percent thought that the fishery was worse (28%) or had no opinion (49%).

The age distributions of harvested Northern Pike, Smallmouth and Largemouth Bass and Walleye are shown in Fig. 2.2.3.

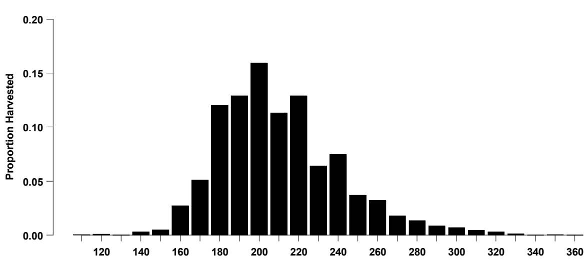


FIG .2.2.1. Length distributions of Yellow Perch sampled (harvested fish) during the Lake St. Francis recreational fishery survey, 2018. The mean fork length of harvested Yellow Perch was 211 mm.

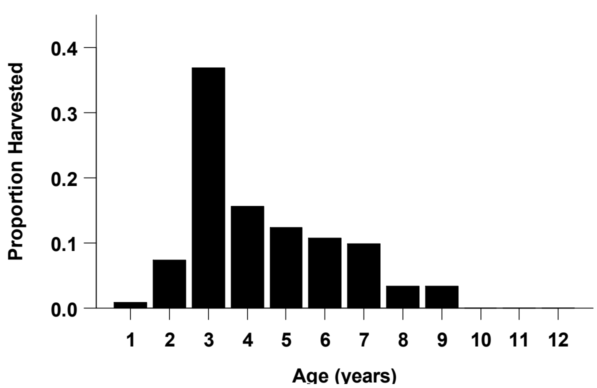


FIG. 2.2.2. Age distribution of Yellow Perch sampled (harvested fish) during the Lake St. Francis recreational fishery survey, 2018. Mean age of harvested fish was 4.4 years.

TABLE 2.2.3. Species-specific statistics for open-water angling from on Lake St. Francis, St. Lawrence River from 2003 to 2018. Shown are angling effort (for all anglers), number of fish caught and harvested (by all anglers), catch and harvest per angler hour (CUE and HUE, respectively) as well as release rates. The design and timeframe surrounding Lake St. Francis Angler Surveys from 2003 to 2018 are comparable so these data are presented.

	Year			
	2003	2009	2013	2018
Angling Effort (angler hours):				
Total All Anglers	78,245	82,619	63,121	53,567
Targeted Yellow Perch	51,467	56,585	39,949	24,005
Percent of Effort for Perch	66%	68%	63%	45%
Number of Fish Caught (all anglers):				
Yellow Perch	687,718	819,273	363,217	175,103
Northern Pike	3,231	2,030	282	1,444
Smallmouth Bass	3,713	8,826	7,544	8,523
Walleye	4,088	7,432	7,671	6,874
Number of Fish Harvested (all anglers):				
Yellow Perch	312,973	308,620	144,925	79,690
Northern Pike	942	457	101	245
Smallmouth Bass	1,618	2,766	1,716	1,048
Walleye	3,393	6,147	4,498	4,958
Yellow Perch Angling Success:				
CUE	13.4	14.5	9.1	7.3
HUE	6.1	5.5	3.6	3.3
Release Rate	55%	62%	60%	55%

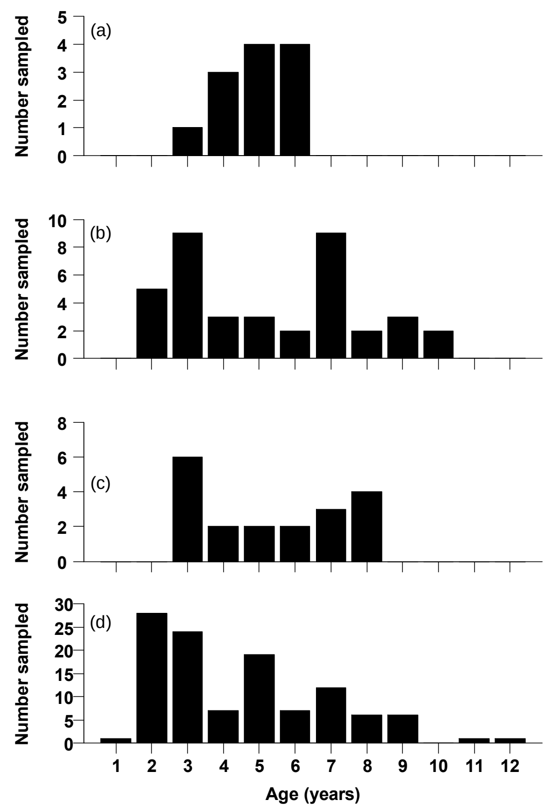


FIG. 2.2.3. Age distributions of (a) Northern Pike, (b) Smallmouth Bass, (c) Largemouth Bass and (d) Walleye (harvested fish) during the Lake St. Francis recreational fishery survey, 2018.

2.3 Bay of Quinte Volunteer Walleye Angler Diary Program

J. A. Hoyle, Lake Ontario Management Unit

A volunteer angler diary program was conducted during late-summer and fall 2018 on the Bay of Quinte and Kingston Basin, eastern Lake Ontario. The diary program focused on the popular late-summer and fall recreational fishery for "trophy" Walleye, primarily on the middle and lower reaches of Bay of Quinte. Increasingly in recent years, a late summer fishery for large migratory Walleye occurs in the Kingston Basin of eastern Lake Ontario; this component of the fishery was also targeted for volunteer anglers. This was the seventh year of the diary program. Anglers that volunteered to participate were given a personal diary and asked to record information about their daily fishing trips and catch (see Fig. 2.3.1). A total of 18 diaries were returned as of February 2019. We thank all volunteer anglers for participating in the program. A map showing the distribution of volunteer addresses of origin is shown in Fig. 2.3.2.

Objectives of the diary program included:

- engage and encourage angler involvement in monitoring the fishery;
- characterize late summer/fall Walleye angling effort, catch, and harvest (including geographic distribution);
- characterize the size distribution of Walleye caught (kept and released);
- characterize species catch composition.

Two of the 18 returned diaries reported zero fishing trips. The number of fishing trips reported in each of the remaining 16 diaries ranged from one to 23 trips. Fishing trips were reported for 127 out of a possible 154 calendar days from Jul 14 to Dec 15, 2018. There were from one to five volunteer angler boats fishing on each of the 127 days, and a total of 126 trip reports targeted at Walleye; 25 charter boat trips

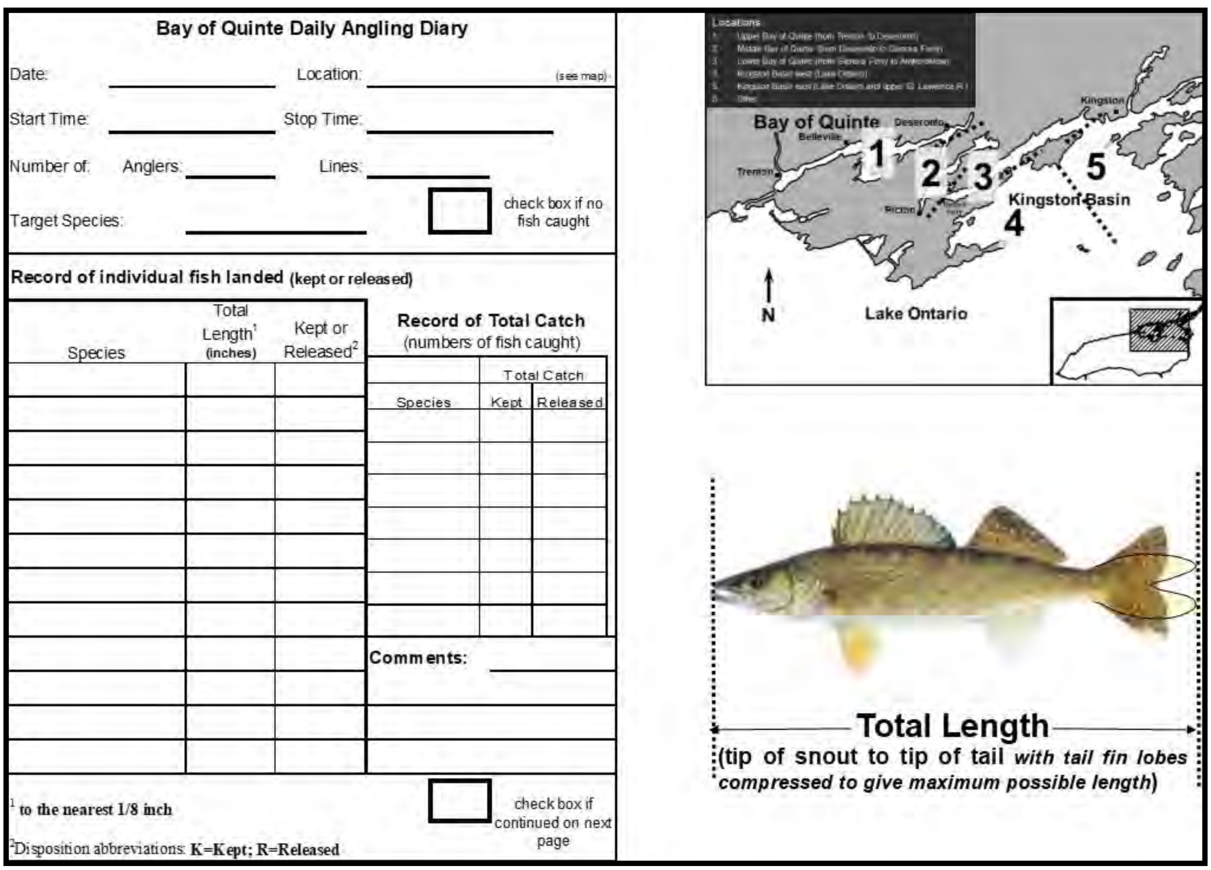


FIG. 2.3.1. Volunteer angler diary used to record information about daily fishing trips and catch.

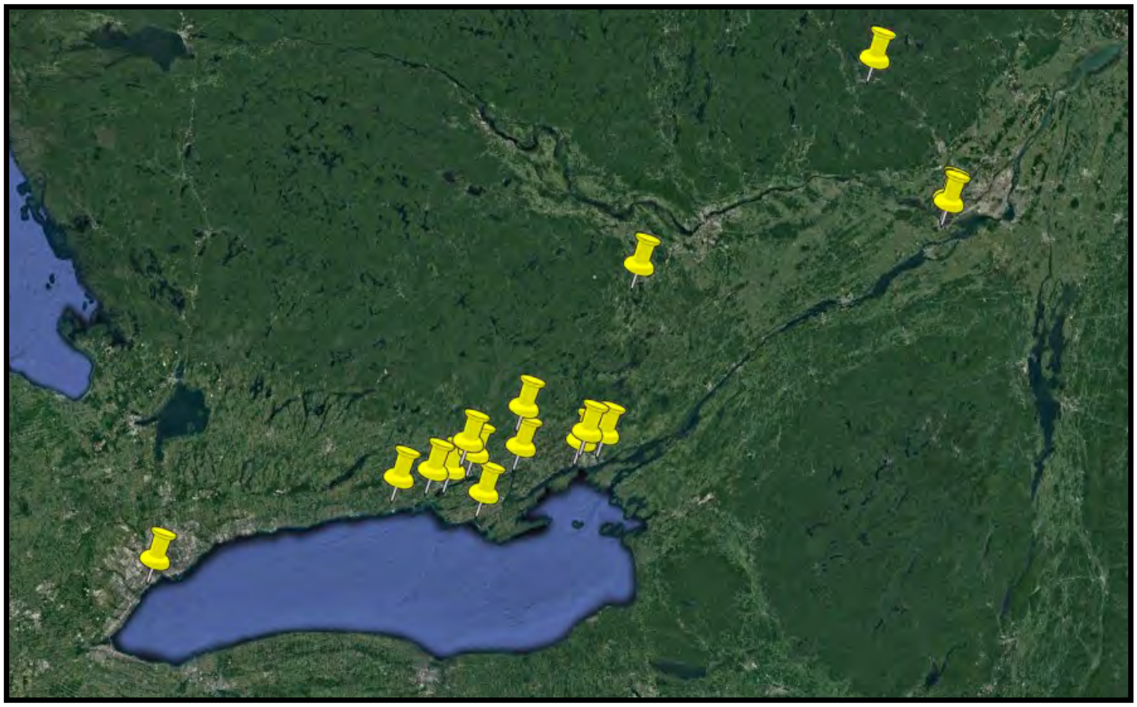


FIG. 2.3.2. Map showing the distribution of volunteer addresses of origin. Image courtesy of Google Earth.

and 101 non-charter boat trips (Table 2.3.1). Of the 126 trips, 91 (72%) were made on Locations 2 and 3 (middle and lower reaches of the Bay of Quinte), and 26 trips (21%) were made in Locations 4 and 5 (Kingston Basin, eastern Lake Ontario; see Fig. 2.3.1). The overall average fishing trip duration was 7.2 hours for charter boats and 5.3 hours for non-charter boats, and the average numbers of anglers per boat trip were 4.8 and 2.2 for charter and non-charter boats, respectively (Table 2.3.1). In Locations 3,4 and 5, where two lines are permitted, most anglers used two lines (1.9 rods per angler on average).

Fishing Effort

A total of 2,143 angler hours of fishing effort was reported by volunteer anglers (Table 2.3.2). The seasonal pattern of fishing effort is shown in Fig. 2.3.3. Highest fishing effort occurred in November. Most fishing effort occurred in Location 3 (51%; lower Bay) (Fig. 2.3.4). Locations 4 and 5 (Kingston Basin, eastern Lake Ontario) accounted for 15% of the total fishing effort.

Catch

Seven species and a total of 463 fish were reported caught by volunteer anglers. The number of Walleye caught was 387; 186 (48%) kept and 201 (52%) released (Table 2.3.3). The next most abundant species caught was Freshwater Drum (37) followed by Northern Pike (19), White Bass (11), and Smallmouth Bass (6).

TABLE 2.3.1. Reported total number of boat trips, average trip duration, and average number of anglers per trip for charter and non-charter Walleye fishing trips during late summer and fall 2012-2018 on the Bay of Quinte and the Kingston Basin, eastern Lake Ontario.

Year	Trip type	Total number of boat trips	Average trip duration (hours)	Average number of anglers per trip
2012	Charter	121	7.7	4.4
	Non-charter	137	5.6	2.3
2013	Charter	72	7.4	4.0
	Non-charter	83	4.9	2.1
2014	Charter	123	7.4	4.4
	Non-charter	87	5.3	2.3
2015	Charter	118	7.5	4.3
	Non-charter	115	5.2	1.9
2106	Charter	33	7.2	4.7
	Non-charter	62	4.5	1.8
2017	Charter	77	6.2	4.0
	Non-charter	87	6.0	2.0
2018	Charter	25	7.2	4.8
	Non-charter	101	5.3	2.2

TABLE 2.3.2. Reported total number of diaries (with at least one reported fishing trip), boat trips and effort, total angler effort, total number of Walleye caught, harvested, and released, average number of Walleye caught per boat fishing trip, average number of Walleye caught per boat hour, average number of Walleye caught per angler hour, and the "skunk" rate (percentage of trips with no Walleye catch) for Walleye fishing trips during late summer and fall 2012-2018 on the Bay of Quinte and the Kingston Basin, eastern Lake Ontario.

	Year						
Statistic	2012	2013	2014	2015	2016	2017	2018
Number of diaries	22	19	20	22	11	20	16
Number of boat trips	258	155	210	235	93	164	126
Boat effort (hours)	1,694	941	1,375	1,506	498	1,001	719
Angler effort (hours)	5,915	3,093	5,164	5,266	1,602	3,262	2,143
Catch	542	574	682	436	184	604	387
Harvest	291	307	336	285	112	350	186
Released	251	267	346	151	72	254	201
Fish per boat hour	2.1	3.7	3.2	1.9	2.0	3.7	3.1
Fish per boat trip	0.305	0.557	0.463	0.307	0.289	0.601	0.615
Fish per angler hour	0.102	0.193	0.137	0.138	0.122	0.210	0.279
"Skunk rate"	36%	19%	27%	34%	44%	24%	25%

Fishing Success

The overall fishing success for Walleye in fall 2018 was 3.1 Walleye per boat trip or 0.279 fish per angler hour of fishing (Table 2.3.2). Seventy-five percent of all boat trips reported catching at least one Walleye ("skunk rate" 25%). Seasonal fishing success, for geographic Locations 2, 3 and 4 combined, is shown in Fig. 2.3.5. Success was high from July through September, low in October, and was high in late November and early December.

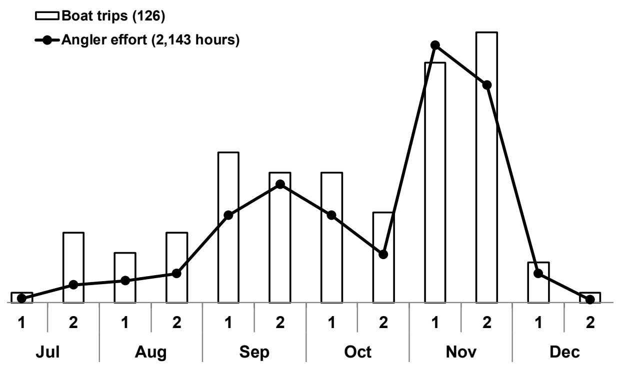


FIG. 2.3.3. Seasonal breakdown (summarized by first and second half of each month from the first half of Jul to the end of Dec) of fishing effort (boat trips and angler hours) reported by volunteer Walleye anglers during 2018 on the Bay of Quinte and the Kingston Basin, eastern Lake Ontario.

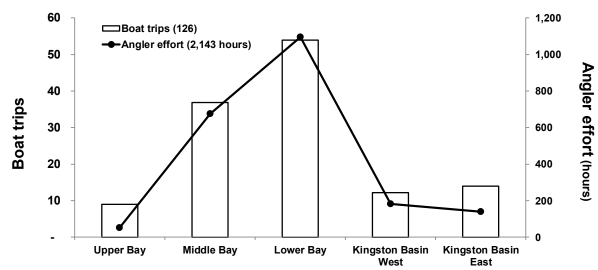


FIG. 2.3.4. Geographic breakdown of fishing effort (boat trips and angler hours) reported by volunteer Walleye anglers during late summer and fall 2018 on the Bay of Quinte and the Kingston Basin, eastern Lake Ontario.

TABLE 2.3.3. Number of fish, by species, reported caught (kept and released) by volunteer anglers during late summer and fall 2012-2018 on the Bay of Quinte and the Kingston Basin, eastern Lake Ontario.

	2012		2013		2014		2015		2016		2017		2018	
Species	Kept	Released	Kept	Released	Kept	Released	Kept	Released	Kept	Released	Kept	Released	Kept	Released
Longnose Gar	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Chinook Salmon	0	1	0	0	0	2	0	0	0	0	0	0	0	0
Rainbow Trout	0	0	0	0	0	3	0	0	0	0	0	0	0	0
Brown Trout	1	0	0	0	0	1	1	0	0	0	0	0	0	0
Lake Trout	0	1	0	0	0	4	3	10	0	1	1	6	0	0
Lake Whitefish	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Northern Pike	1	47	4	20	2	36	2	14	1	18	1	9	0	19
White Perch	0	0	0	12	0	0	1	0	0	11	0	0	0	2
White Bass	0	0	0	3	0	7	9	5	0	5	6	8	5	6
Morone sp.	1	15	0	0	0	0	0	0	0	0	0	0	0	0
Sunfish	0	0	0	0	0	0	0	2	0	0	0	2	0	0
Smallmouth Bass	0	0	0	3	1	2	0	1	1	1	0	8	0	6
Largemouth Bass	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yellow Perch	4	32	2	6	0	0	1	0	0	0	0	0	0	1
Walleye	292	252	307	267	338	350	285	151	112	72	350	254	186	201
Freshwater Drum	1	43	0	25	1	53	8	81	0	38	0	58	0	37

Length Distribution of Walleye Caught

Ninety-six percent of Walleye caught by volunteer anglers were between 16 and 30 inches total length (Fig. 2.3.6). Over the seven years of the volunteer angler diary program 3,279 Walleye lengths have been reported (Fig. 2.3.7). The proportion of Walleye released was highest for smallest and largest fish and lowest for fish of intermediate size. Only 24% of fish caught that were between 16 and 25 inches were released. In contrast, 59% of fish less than 16 inches and 67% of fish greater than 25 inches were released.

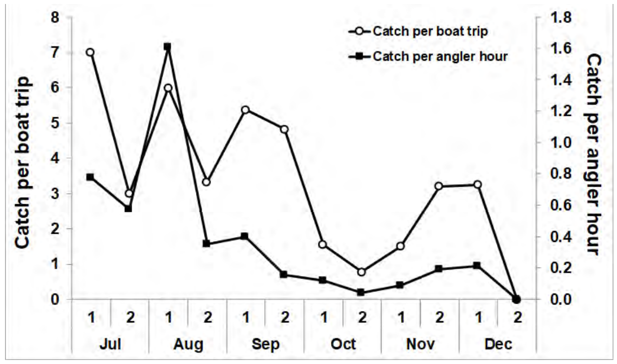


FIG. 2.3.5. Walleye fishing success (catch per boat trip and per angler hour) reported by volunteer Walleye anglers in areas 2, 3 and 4 during late summer and fall 2018 on the Bay of Quinte and the Kingston Basin, eastern Lake Ontario (summarized by first and second half of each month from July to December).

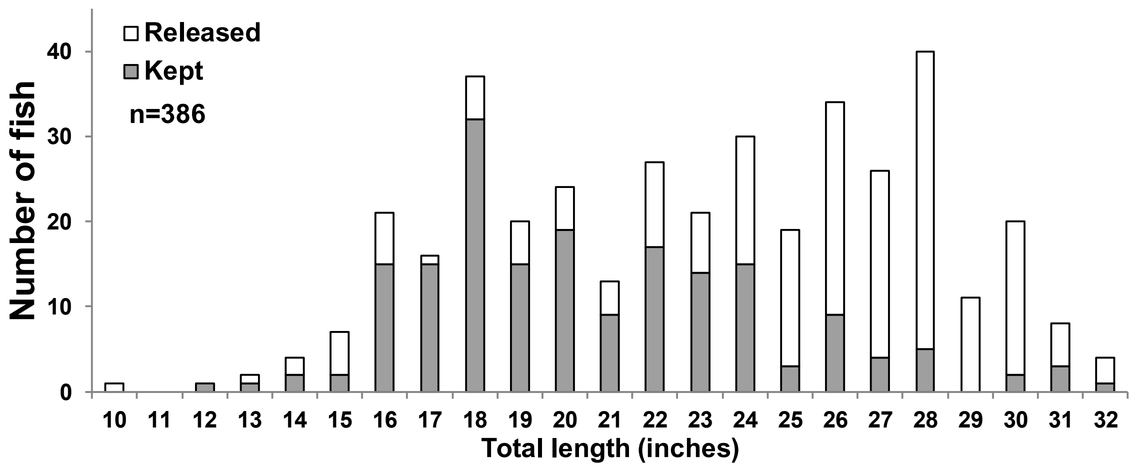


FIG. 2.3.6. Length distribution of 386 Walleye caught (kept and released) by volunteer Walleye anglers during late summer and fall 2018 on the Bay of Quinte and the Kingston Basin, eastern Lake Ontario.

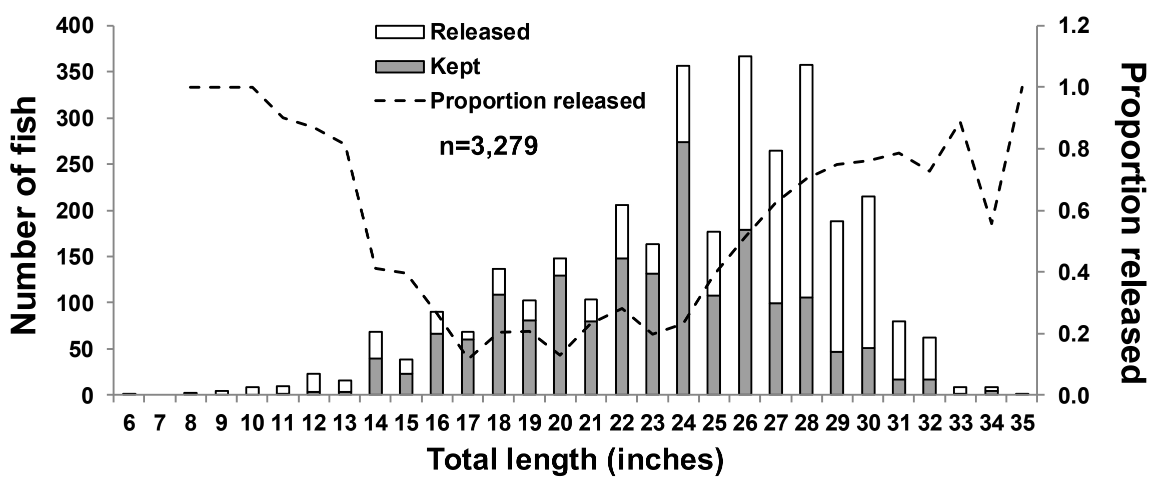


FIG. 2.3.7. Length distribution of 2,304 Walleye caught (kept and released) by volunteer Walleye anglers during late summer and fall 2012-2018 on the Bay of Quinte and the Kingston Basin, eastern Lake Ontario. Also shown is the proportion of fish released (dotted line)

2.4 Lake Ontario Chinook Salmon Tournament Sampling

M. J. Yuille, Lake Ontario Management Unit

Since 2010, the Lake Ontario Management Unit has been attending Lake Ontario fishing tournaments to sample Chinook Salmon periodically throughout the summer. On average LOMU visits six tournaments a season and collects biological information on harvested angler caught fish. Initially, LOMU attended the tournaments to increase coded wire tag recovery during the Mass Marking Program (see Section 7.1 for more information). The tournament sampling program has continued as it provides insight into the age structure, condition and health of Lake Ontario salmon and trout throughout the summer months. With the exception of years when LOMU conducts the Western Basin Angler Survey (Section 7.1), these tournament sampling events provide the only window for viewing Chinook health and condition throughout the summer in Canadian waters.

Due to inclement weather conditions, LOMU staff attended three tournaments in 2018 (Table 2.4.1), sampling a total of 55 Chinook Salmon, 23 Coho Salmon, 5 Lake Trout, 3 Rainbow Trout and 1 Atlantic Salmon. The average total length and weight for a Chinook Salmon sampled in the 2018 tournaments was 775 mm (30.5") and 5,610 g (12.37 lbs), respectively (Table 2.4.2). The heaviest fish sampled by LOMU in the 2018 tournaments weighed 11,360 g (25.00 lbs).

Chinook Salmon body condition was determined as the estimated weight (g) of a 914 mm (36") total length fish (Fig. 2.4.1). Overall, Chinook Salmon body condition declined from 2010 to 2014 (Fig. 2.4.1). Since this time Chinook Salmon body condition increased to the highest value in the time series in 2017. In 2018, body condition of Chinook Salmon sampled in tournaments took a sharp decline and is at the lowest point in the nine-year time series (Fig. 2.4.1). It should be noted that despite the variability observed from year to year, the absolute difference in body condition from 2010 to 2018 is 1,590 g (3.5 lbs).

The Lake Ontario Management Unit would like to thank all the tournament organizers, volunteers and anglers involved in making this program a success over the past eight years.

TABLE 2.4.1. Tournaments attended by the Lake Ontario Management Unit in 2018.

Date	Tournament
Saturday, June 9, 2018	Strait Line Anglers Salmon Challenge
Saturday, June 16, 2018	6th Annual Veteran's Salmon Derby
Saturday, July 28, 2018	Port Whitby Salmon Series

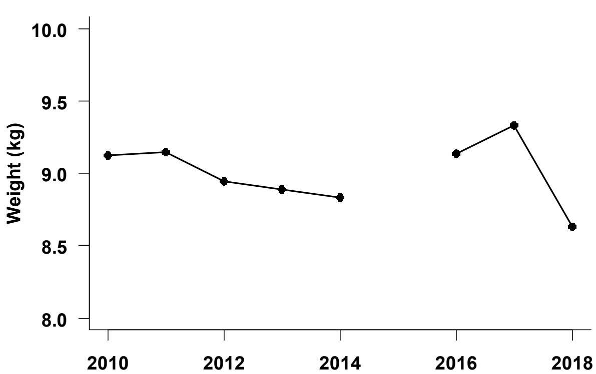


FIG. 2.4.1. Body condition (estimated weight at 914 mm (36") total length) of Lake Ontario Chinook Salmon sampled through June to August, 2010 – 2018.

TABLE 2.4.2. Summary of summer Chinook Salmon sampling on Lake Ontario, 2010 – 2018.

Year	n	Avg. Total Length (mm)	Weight (g) Avg.	Min.	Max.
2010	405	733	5.83	0.22	17.72
2011	220	831	6.58	0.40	16.00
2012	221	864	7.72	0.34	15.14
2013	340	872	8.02	0.39	15.96
2014	127	768	5.98	0.55	14.70
2016	118	811	6.92	0.41	15.01
2017	88	824	7.20	0.40	14.34
2018	55	775	5.61	0.68	11.36

3. Commercial Fishery

3.1 Lake Ontario and St. Lawrence River Commercial Fishing Liaison Committee

A. Todd, Lake Ontario Management Unit

The Lake Ontario and St. Lawrence River Commercial Fishery Liaison Committee (LOLC) consists of Ontario Commercial Fishing License holders that are appointed to represent each of the quota zones, as well as representatives of the Ontario Commercial Fisheries' Association, and MNRF. This committee provides advice to the Lake Ontario Manager on issues related to management of the commercial fishery and provides a forum for dialogue between the MNRF and the commercial industry.

The committee met twice during 2018 (February 14, and November 1). Topics of discussion at these LOLC meetings included commercial harvest summaries, status of fish stocks (including Yellow Perch, Lake Whitefish, Sunfish, Walleye, and Black Crappie), quotas and "pools", eel status and trap and transfer program, Northern Pike harvest management, aquatic invasive species, and turtle bycatch mitigation.

3.2 Quota and Harvest Summary

E. Brown and J. A. Hoyle, Lake Ontario Management Unit

Lake Ontario supports a commercial fish industry with most of the commercial harvest occurring in Canadian waters of Lake Ontario east of Brighton (including the Bay of Quinte, East and West Lakes) and the St. Lawrence River (Fig. 3.2.1). The waters west of Brighton (quota zone 1 -8) currently have no commercial licences. Commercial harvest statistics for 2018 were obtained from the commercial fish harvest information system (CFHIS) which is managed, in partnership, by the Ontario Commercial Fisheries Association (OCFA) and MNRF. Commercial quota, harvest and landed value statistics for Lake Ontario, the St. Lawrence River and East and West Lakes, for 2018, are shown in Tables 3.2.1 (base quota), 3.2.2 (issued quota), 3.2.3 (harvest) and 3.2.4 (landed value).

The total harvest (landed value) of all species was 335,493 lb ($454,354) in 2018, down 162,655 lb (33%) from 2017. The harvest (landed value) for Lake Ontario, the St. Lawrence River, and East and West Lakes was 230,388 lb ($319,053), 73,406 lb ($101,468), and 31,699 lb ($35,532), respectively (Fig. 3.2.2 and Fig. 3.2.3). Yellow Perch, Lake Whitefish, Sunfish and Walleye were the dominant species in the harvest for Lake Ontario. Yellow Perch was dominant in the St. Lawrence River. Sunfish was the dominant fish in East and West Lakes.

Major Fishery Trends

Harvest and landed value trends for Lake Ontario (Embayments included) and the St. Lawrence River are shown in Fig. 3.2.4 and Fig. 3.2.5. Having declined in the early 2000s, commercial harvest appeared to have stabilized over the 2003-2013 time-period at about 400,000 lb and 150,000 lb for Lake Ontario (Fig. 3.2.4) and the St. Lawrence River (Fig. 3.2.5) respectively. In 2014, harvest declined again in

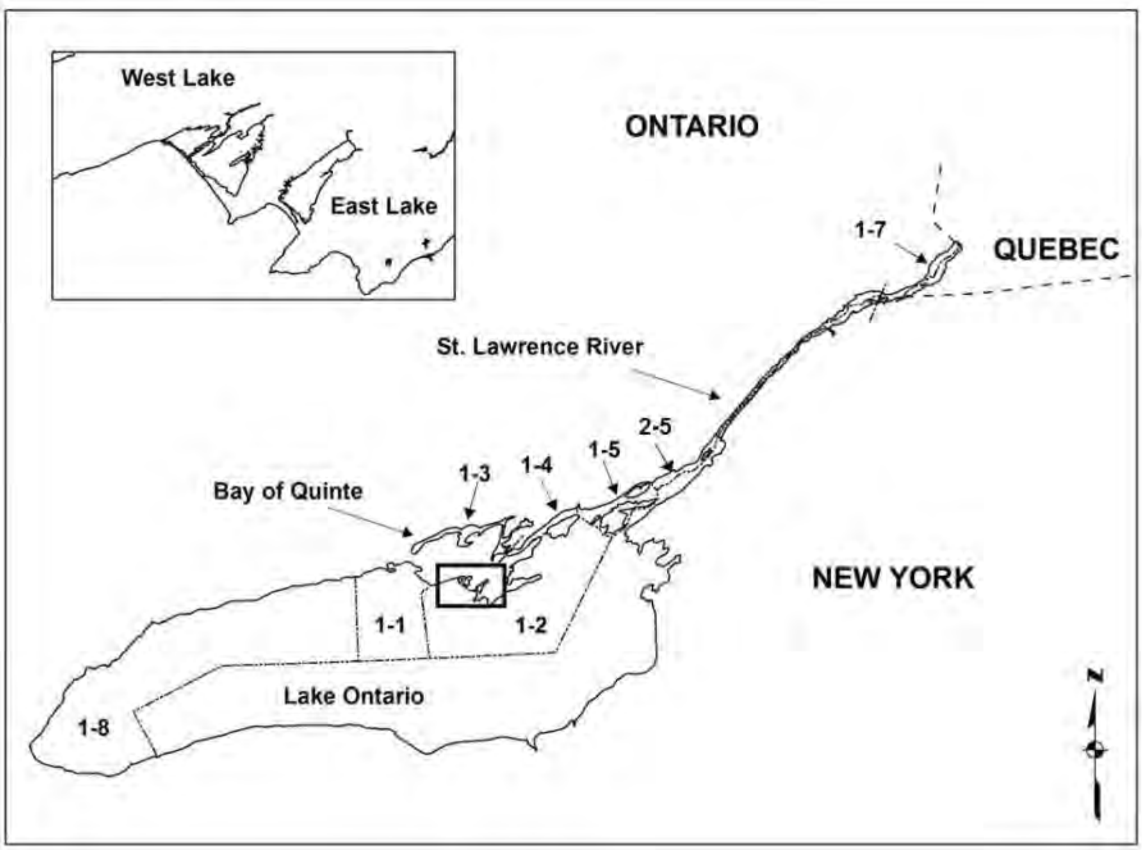


FIG. 3.2.1. Map of Lake Ontario and the St. Lawrence River showing commercial fishing quota zones in Canadian waters.

TABLE 3.2.1. Commercial fish **base quota** (lb), by quota zone, in the Canadian waters of Lake Ontario and the St. Lawrence River, East and West Lakes (two Lake Ontario embayments), 2018.

	Lake Ontario				St. Lawrence River			East Lake	West Lake	Base Quota by Waterbody		
Species	1-1	1-2	1-3	1-4	1-5	2-5	1-7	1	1	Lake Ontario	St. Lawrence River	Total
Black Crappie	4,540	3,000	14,823	1,100	14,170	17,590	4,840	3,100	9,850	23,463	36,600	73,013
Lake Whitefish	6,548	97,742	12,307	18,282	0	0	0	0	0	134,879	0	134,879
Sunfish	28,130	0	0	0	0	0	0	14,600	18,080	28,130	0	60,810
Walleye	4,209	32,930	0	10,954	0	0	0	0	0	48,093	0	48,093
Yellow Perch	18,222	73,458	88,816	88,824	51,789	53,001	18,048	896	2,829	269,320	122,838	395,882
Total	61,649	207,130	115,946	119,159	65,959	70,591	22,888	18,596	30,759	503,884	159,438	712,677

TABLE 3.2.2. Commercial fish **issued quota** (lb), by quota zone, in the Canadian waters of Lake Ontario and the St. Lawrence River, East and West Lakes (two Lake Ontario embayments), 2018.

	Lake Ontario				St. Lawrence River			East Lake	West Lake	Issued Quota by Waterbody		
Species	1-1	1-2	1-3	1-4	1-5	2-5	1-7	1	1	Lake Ontario	St. Lawrence River	Total
Black Crappie	2,270	1,500	11,454	550	7,085	8,795	4,840	3,100	9,850	15,774	20,720	49,444
Lake Whitefish	4,480	111,003	6,641	6,816	0	0	0	0	0	128,940	0	128,940
Sunfish	28,130	0	0	0	0	0	0	14,600	18,080	28,130	0	60,810
Walleye	2,123	12,452	0	35,518	0	0	0	0	0	50,092	0	50,092
Yellow Perch	12,859	39,384	72,594	65,865	47,009	48,701	18,048	896	2,829	190,702	113,758	308,185
Total	49,863	164,339	90,689	108,748	54,094	57,496	22,888	18,596	30,759	413,639	134,478	597,472

TABLE 3.2.3. Commercial **harvest** (lb), by quota zone, for fish species harvested from the Canadian waters of Lake Ontario and the St. Lawrence River, East and West Lakes (two Lake Ontario embayments), 2018.

	Lake Ontario				St. Lawrence River			East Lake	West Lake	Totals		
Species	1-1	1-2	1-3	1-4	1-5	2-5	1-7	1	1	Lake Ontario	St. Lawrence River	All Waterbodies
Black Crappie	10	0	4,964	30	1,124	676	462	0	1,819	5,004	2,262	9,085
Bowfin	0	2	1,950	0	922	1,183	119	30	274	1,952	2,224	4,480
Brown Bullhead	0	84	3,115	120	1,040	2,153	7,592	0	10	3,319	10,785	14,114
Common Carp	0	150	2,549	1,338	0	0	0	0	313	4,037	0	4,350
Freshwater Drum	137	256	3,348	12,711	0	0	0	0	0	16,452	0	16,452
Cisco	8	231	2,198	551	0	0	0	0	69	2,988	0	3,057
Lake Whitefish	0	54,195	1,785	177	0	0	0	0	0	56,157	0	56,157
Northern Pike	881	265	4,801	1,517	1,118	0	0	610	1,363	7,464	1,118	10,555
Rock Bass	1,851	1,536	3,545	717	360	668	90	2,032	1,983	7,649	1,118	12,782
Sunfish	1,028	0	24,317	98	4,121	776	191	7,551	13,071	25,443	5,088	51,153
Walleye	596	1,649	0	23,956	0	0	0	0	0	26,201	0	26,201
White Bass	0	365	12	3,980	0	0	0	0	0	4,357	0	4,357
White Perch	44	193	4,406	3,177	16	0	0	463	1,606	7,820	16	9,905
White Sucker	122	301	9,844	3,003	0	0	0	0	30	13,270	0	13,300
Yellow Perch	3,924	5,111	18,931	20,309	18,936	21,227	10,632	0	475	48,275	50,795	99,545
Total	8,601	64,338	85,765	71,684	27,637	26,683	19,086	10,686	21,013	230,388	73,406	335,493

TABLE 3.2.4. Commercial **harvest (lb), price per lb, and landed value** for fish species harvested from the Canadian waters of Lake Ontario and the St. Lawrence River, and the total for all waterbodies including East and West Lakes, 2018.

	Lake Ontario			St. Lawrence River			All Waterbodies		
Species	Harvest	Price per lb	Landed value	Harvest	Price per lb	Landed value	Harvest	Price per lb	Landed value
Black Crappie	5,004	$3.29	$16,452	2,262	$2.71	$6,121	9,085	$3.04	$27,601
Bowfin	1,952	$0.30	$586	2,224	$0.60	$1,326	4,480	$0.50	$2,261
Brown Bullhead	3,319	$0.26	$858	10,785	$0.45	$4,835	14,114	$0.41	$5,729
Common Carp	4,037	$0.15	$616	0			4,350	$0.15	$663
Freshwater Drum	16,452	$0.10	$1,587	0			16,452	$0.10	$1,587
Cisco	2,988	$0.29	$861	0			3,057	$0.29	$883
Lake Whitefish	56,157	$1.74	$97,459	0			56,157	$1.74	$97,459
Northern Pike	7,464	$0.37	$2,763	1,118	$0.39	$432	10,555	$0.36	$3,764
Rock Bass	7,649	$0.63	$4,824	1,118	$0.66	$737	12,782	$0.63	$8,116
Sunfish	25,443	$1.26	$31,998	5,088	$1.06	$5,385	51,153	$1.20	$61,339
Walleye	26,201	$2.61	$68,487	0			26,201	$2.61	$68,487
White Bass	4,357	$0.52	$2,252	0			4,357	$0.52	$2,252
White Perch	7,820	$0.45	$3,534	16	$0.60	$10	9,905	$0.48	$4,764
White Sucker	13,270	$0.13	$1,724	0			13,300	$0.13	$1,725
Yellow Perch	48,275	$1.76	$85,052	50,795	$1.63	$82,622	99,545	$1.68	$167,725
Total	230,388		$319,053	73,406		$101,468	335,493		$454,354

both major geographic areas. In 2015, harvest declined in the St. Lawrence River and increased slightly in Lake Ontario. Harvest increased significantly in both areas in 2016 and again in 2017. In 2018, harvest declined in both geographic areas.

Major Species

For major species, commercial harvest relative to issued and base quota information, including annual trends, is shown in Fig. 3.2.6 to Fig. 3.2.19. Price-per-lb trends are also shown. Species-specific price-per-lb values are means across quota zones within a major waterbody (i.e., Lake Ontario and the St. Lawrence River).

Yellow Perch

Yellow Perch 2018 commercial harvest relative to issued and base quota by quota zone and total for all quota zones combined is shown in Fig. 3.2.6. Overall, 25% (99,545 lb) of the Yellow Perch base quota (395,882 lb) was harvested in 2018 down from 45% harvested the previous year. The highest Yellow Perch harvest came from quota zones 2-5 and 1-4. All but one quota zone (1-7) harvested less than 50% of base quota.

Trends in Yellow Perch quota (base), harvest and price-per-lb are shown Fig. 3.2.7. Quota was reduced 20% in 2018 in quota zones 1-1 and 1-2. Quota was increased 10% in quota zones 1-3 and 1-4, and left unchanged in quota zones 1-5, 2-7, 1-7, East Lake and West Lake. Harvest and price-per-lb decreased in 2018 in all quota zones (Fig. 3.2.7).

Lake Whitefish

Lake Whitefish 2018 commercial harvest relative to issued and base quota by quota zone and total for all quota zones combined is shown in Fig. 3.2.8. Overall, 42% (56,157 lb) of the Lake Whitefish base quota was harvested in 2018. Most of the Lake Whitefish harvest came from quota zone 1-2. Lake Whitefish is managed as one population across quota zones. Therefore, quota can be transferred among quota zones. Issued quota and harvest was significantly higher than base quota in quota zone 1-2 (Fig. 3.2.8). Relatively small proportions of base quota were harvested in quota zones 1-1, 1-3 and 1-4.

Trends in Lake Whitefish quota (base), harvest and price-per-lb are shown in Fig. 3.2.9. Base quota remained unchanged in 2018 compared to 2017.

Seasonal whitefish harvest and biological attributes (e.g., size and age structure) information

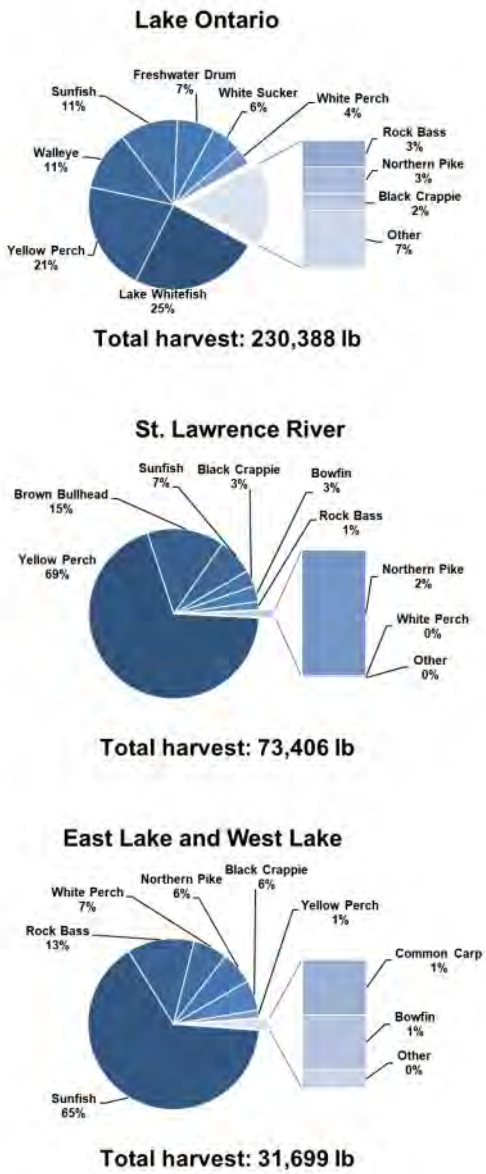


FIG. 3.2.2. Pie-charts showing breakdown of 2018 commercial harvest by species **(% by weight)** for Lake Ontario (quota zones 1-1, 1-2, 1-3, 1-4 and 1-8), the St. Lawrence River (quota zones 1-5, 2-5 and 1-7), and for East and West Lakes combined.

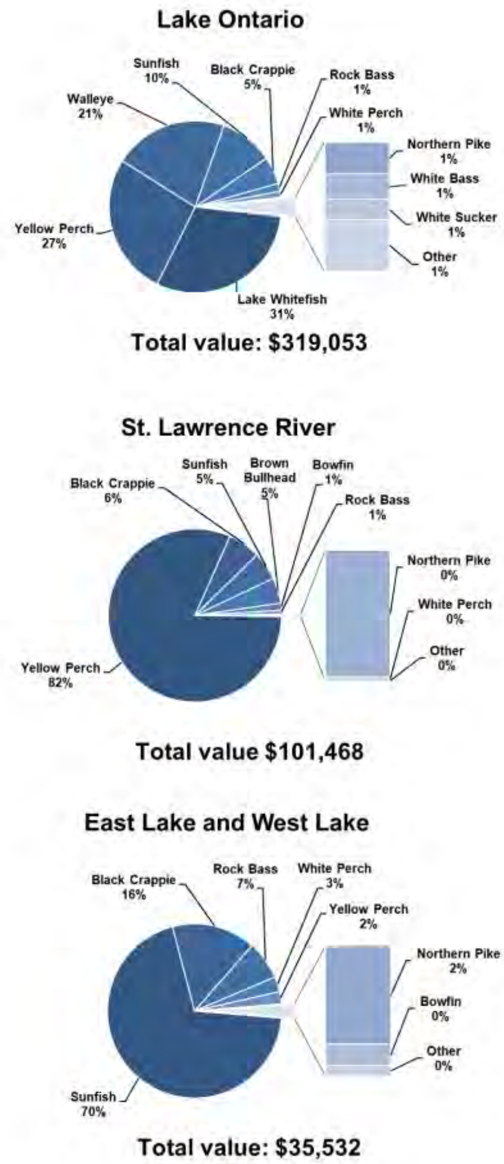


FIG. 3.2.3. Pie-charts showing breakdown of 2018 commercial harvest by species **(% by landed value)** for Lake Ontario (quota zones 1-1, 1-2, 1-3, 1-4 and 1-8), the St. Lawrence River (quota zones 1-5, 2-5 and 1-7), and for East and West Lakes combined.

are reported in Section 3.3. Lake Whitefish price-per-lb has been trending up since 2016.

Walleye

Walleye 2018 commercial harvest relative to issued and base quota by quota zone and total for all quota zones combined is shown in Fig. 3.2.10. Walleye harvest decreased in 2018. Overall, 52% (26,201 lb) of the Walleye base quota (48,092 lb) was harvested. The highest Walleye harvest came from quota zone 1-4. Very small proportions of base quota were harvested in quota zones 1-1 and 1-2. Walleye (like Lake Whitefish) is managed as one fish population across quota zones. Therefore, quota can be transferred among quota zones 1-1, 1-2 and 1-4. In 2018, this resulted in issued quota and harvest being considerably higher than base quota in quota zone 1-4 (Fig. 3.2.10).

Trends in Walleye quota (base), harvest and price-per-lb are shown in Fig. 3.2.11. Quota has remained constant since the early 2000s (just under 50,000 lb for all quota zones combined).

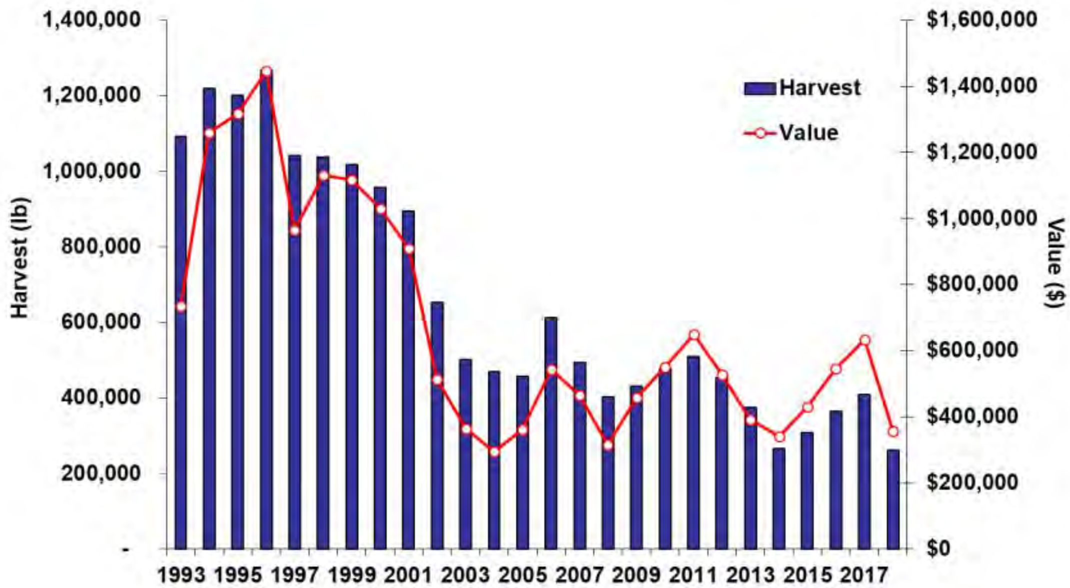


FIG. 3.2.4. Total commercial fishery harvest and value for **Lake Ontario** (Quota Zones 1-1, 1-2, 1-3 ,1-4 and 1-8) and **Embayments** (Quota Zones East Lake and West Lake), 1993-2018 .

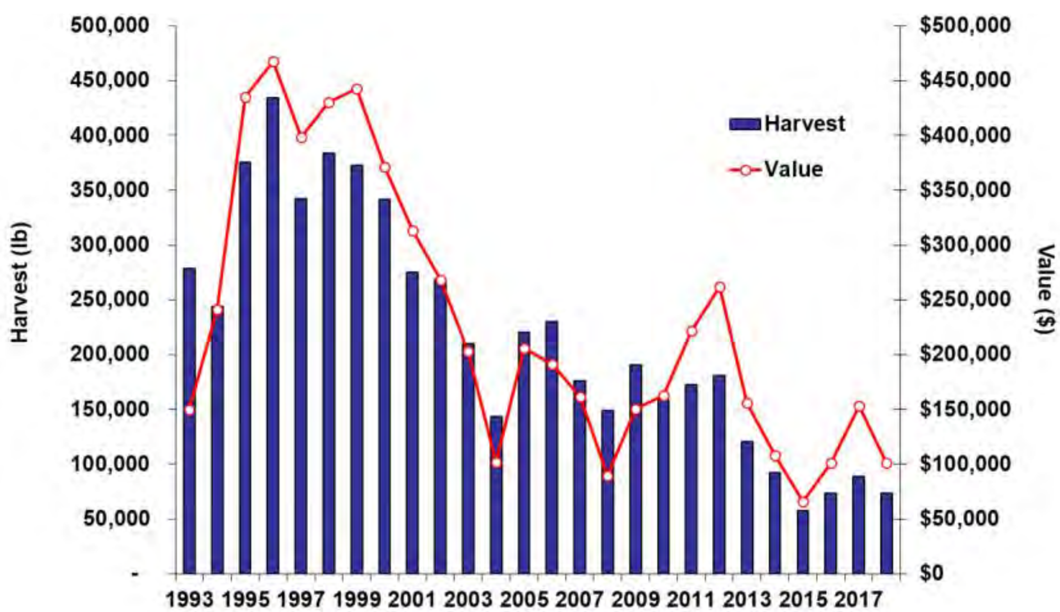


FIG. 3.2.5. Total commercial fishery harvest and value for the **St. Lawrence River** (Quota Zones 1-5, 2-5 and 1-7), 1993-2018.

Walleye price-per-lb has been trending higher for the last number of years.

Black Crappie

Black Crappie 2018 commercial harvest relative to issued and base quota by quota zone and total for all quota zones combined is shown in Fig. 3.2.12. Overall, only 12% (9,085 lb) of the Black Crappie base quota (73,013) was harvested in 2018. The highest Black Crappie harvest came from quota zones 1-3 and West Lake. Only a very small proportion of base quota was harvested in other quota zones.

Trends in Black Crappie quota (base), harvest and price-per-lb are shown in Fig. 3.2.13. Black Crappie harvest has been trending down in

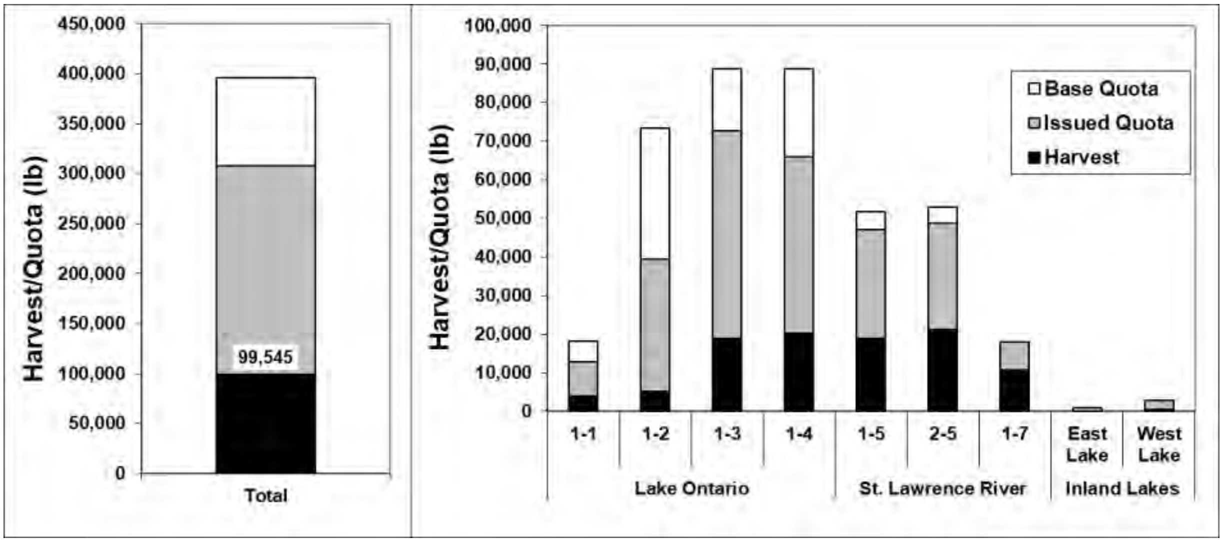


FIG. 3.2.6. **Yellow Perch** commercial harvest relative to issued and base quota (total for all quota zones combined; left panel) and by quota zone (right panel), 2018.

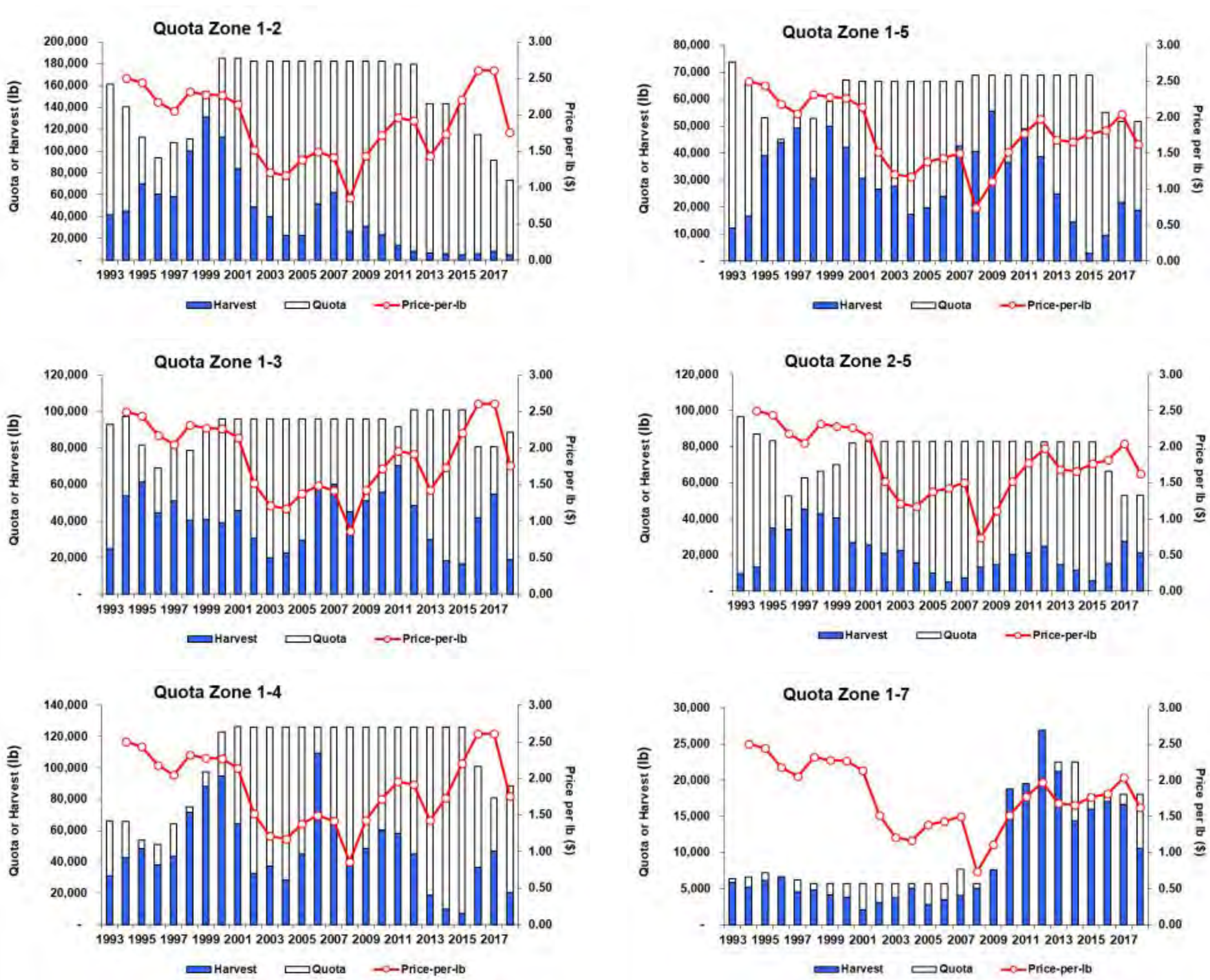


FIG. 3.2.7. Commercial base quota, harvest and price-per-lb for **Yellow Perch** in Quota Zones 1-2, 1-3, 1-4, 1-5, 2-5 and 1-7, 1993-2018.

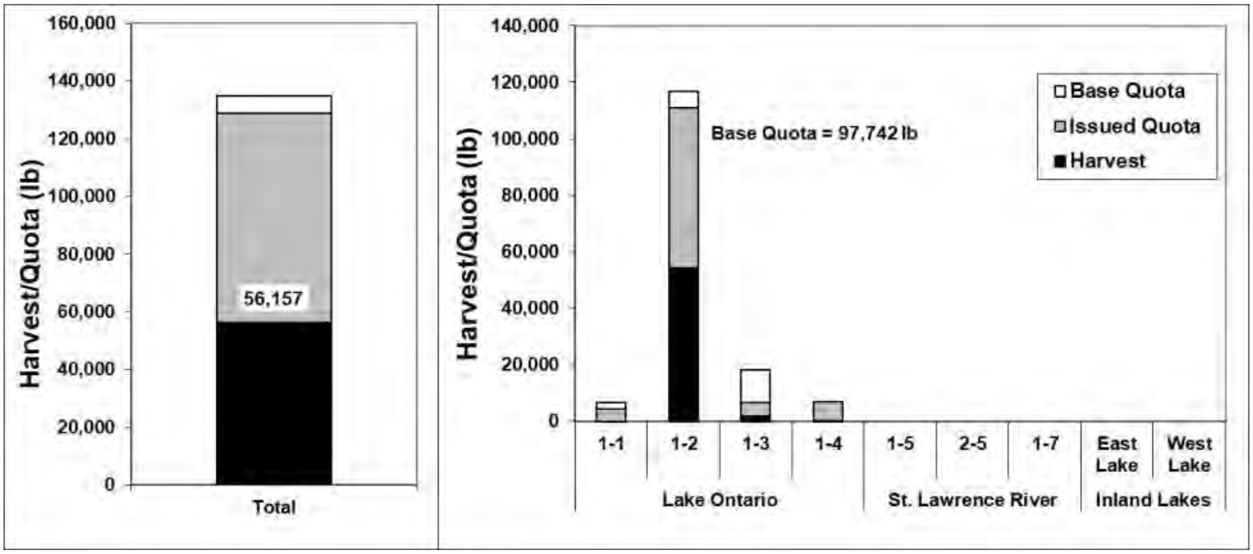


FIG. 3.2.8. **Lake Whitefish** commercial harvest relative to issued and base quota (total for all quota zones combined; left panel) and by quota zone (right panel), 2018.

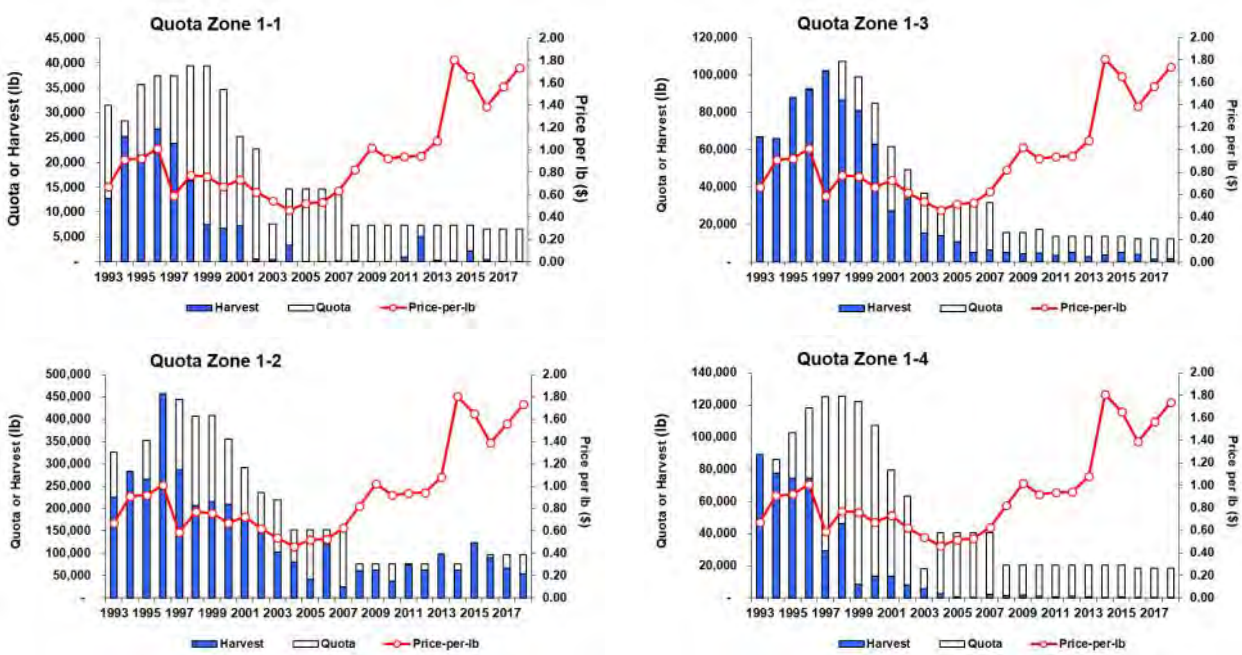


FIG. 3.2.9. Commercial base quota, harvest and price-per-lb for **Lake Whitefish** in Quota Zones 1-1, 1-2, 1-3 and 1-4, 1993-2018.

quota zone 1-3, though slightly increasing in 2018. Harvest remains steady in West Lake. Price -per-lb is currently high.

Sunfish

Sunfish 2018 commercial harvest relative to issued and base quota by quota zone and total for all quota zones combined is shown in Fig. 3.2.14. Only quota zones 1-1 (embayment areas only), East Lake and West Lake have quotas for Sunfish; quota is unlimited in the other zones. Most Sunfish harvest comes from quota zone 1-3, East Lake and West Lake.

Trends in Sunfish quota (base), harvest and price-per-lb are shown in Fig. 3.2.15. In 2018, harvest decreased in quota zone 1-3 and East Lake, and increased in West Lake. Sunfish price-per-lb is currently high and stable.

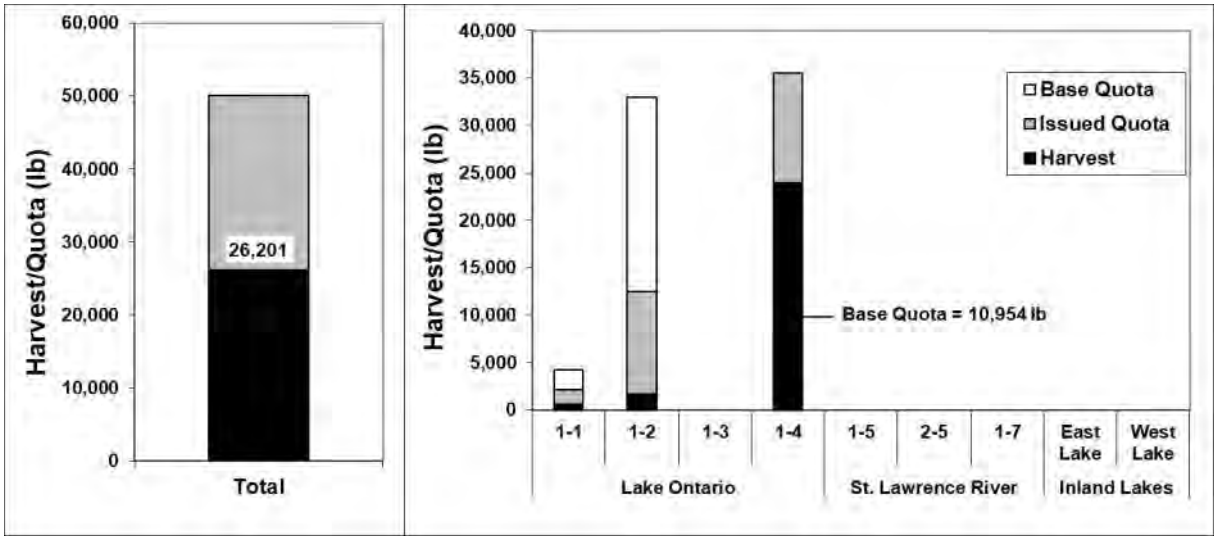


FIG. 3.2.10. **Walleye** commercial harvest relative to issued and base quota (total for all quota zones combined; left panel) and by quota zone (right panel), 2018.

Brown Bullhead

Brown Bullhead 2018 commercial harvest by quota zone and total for all quota zones combined is shown in Fig. 3.2.16. Quota was removed in quota zones 1-1, East Lake and West Lake in 2016 and is now unlimited in all zones. Highest Brown Bullhead harvest came from quota zones 1-3 and 1-7.

Trends in Brown Bullhead quota (base), harvest and price-per-lb are shown in Fig. 3.2.17. Current harvest levels are extremely low relative to past levels.

Northern Pike

Northern Pike 2018 commercial harvest by quota zone is shown in Fig. 3.2.18. Highest pike harvest came from quota zone 1-3.

Trends in Northern Pike harvest and price-per-lb are shown in Fig. 3.2.19. In 2018, harvest declined in all quota zones except 1-2 .

Northern Pike is managed as an incidental harvest fishery. In 2018, the harvest season was closed from April 1st to the first Saturday in May. Historically, this time period accounted for a significant amount of the annual harvest.

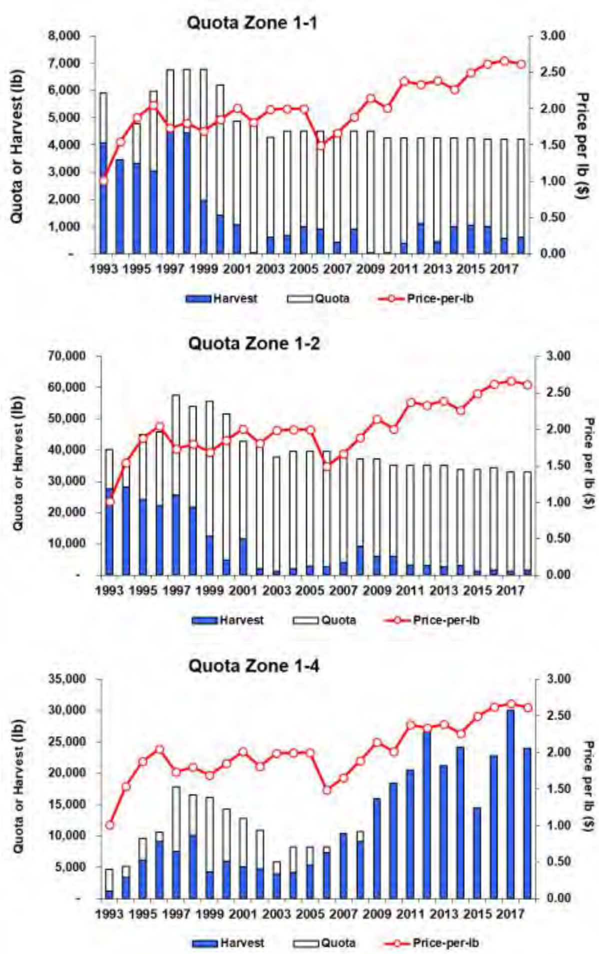


FIG. 3.2.11. Commercial base quota, harvest and price-per-lb for **Walleye** in Quota Zones 1-1, 1-2 and 1-4, 1993-2018.

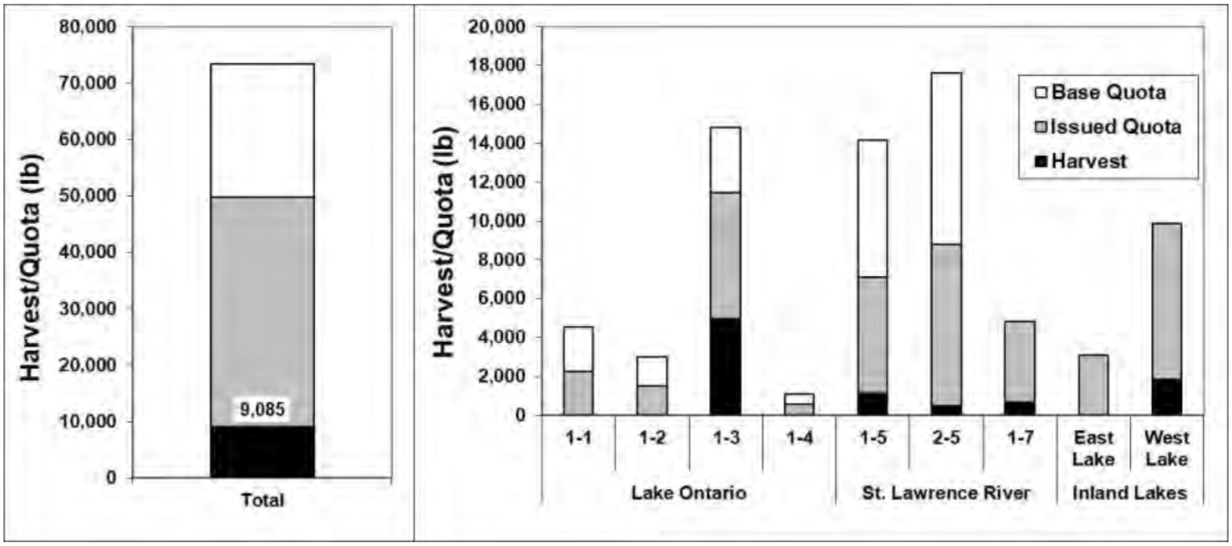


FIG. 3.2.12. **Black Crappie** commercial harvest relative to issued and base quota (total for all quota zones combined; left panel) and by quota zone (right panel), 2018.

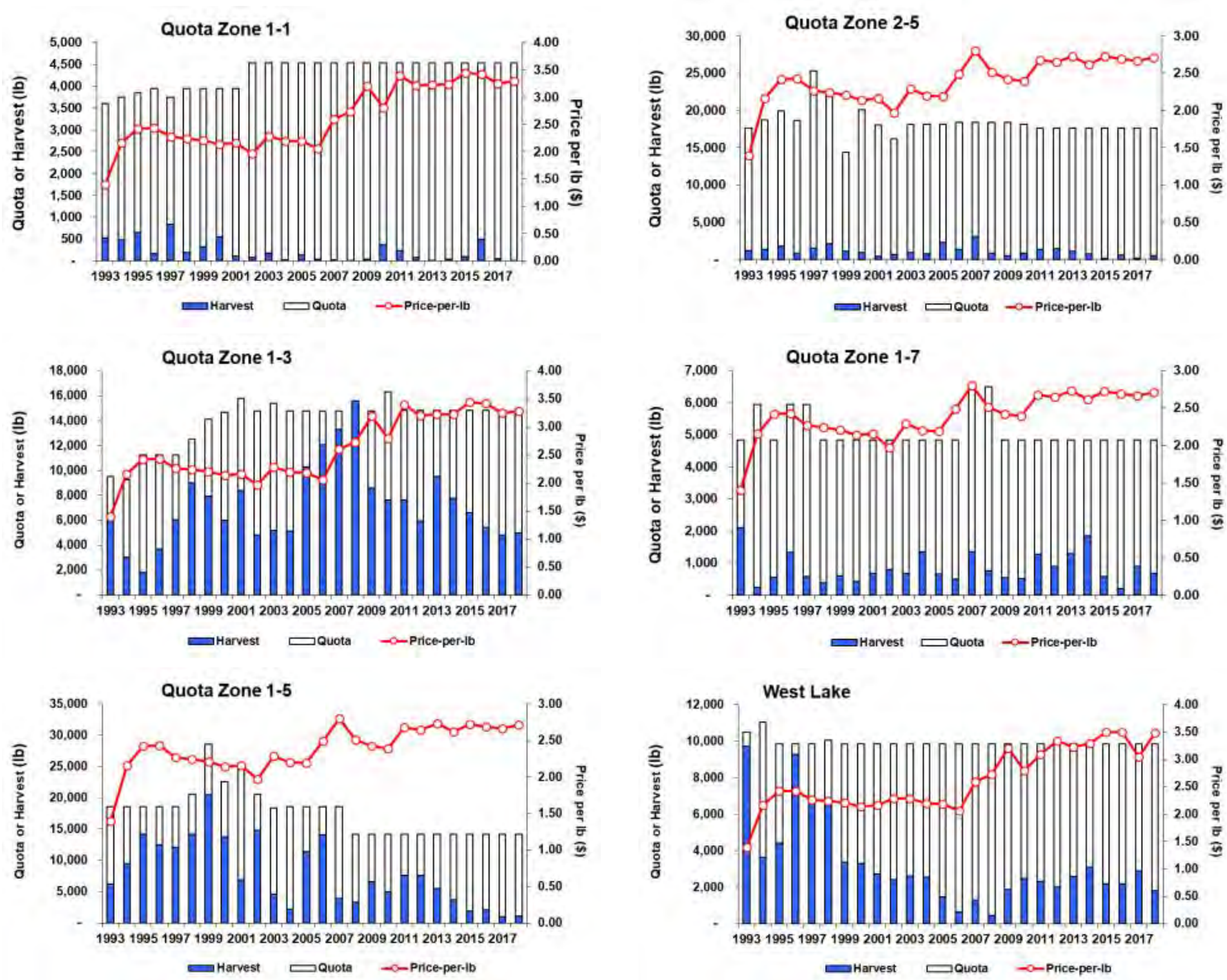


FIG. 3.2.13. Commercial base quota, harvest and price-per-lb for **Black Crappie** in Quota Zones 1-1, 1-3, 1-5, 2-5, 1-7 and West Lake, 1993-2018.

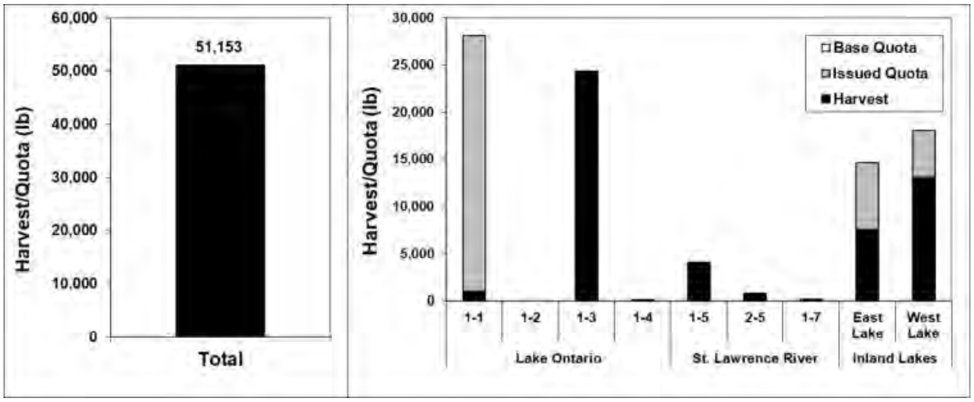


FIG. 3.2.14. **Sunfish** commercial harvest relative to issued and base quota for quota zones 1-1, East Lake and West Lake, 2018. The remaining quota zones have unlimited quota.

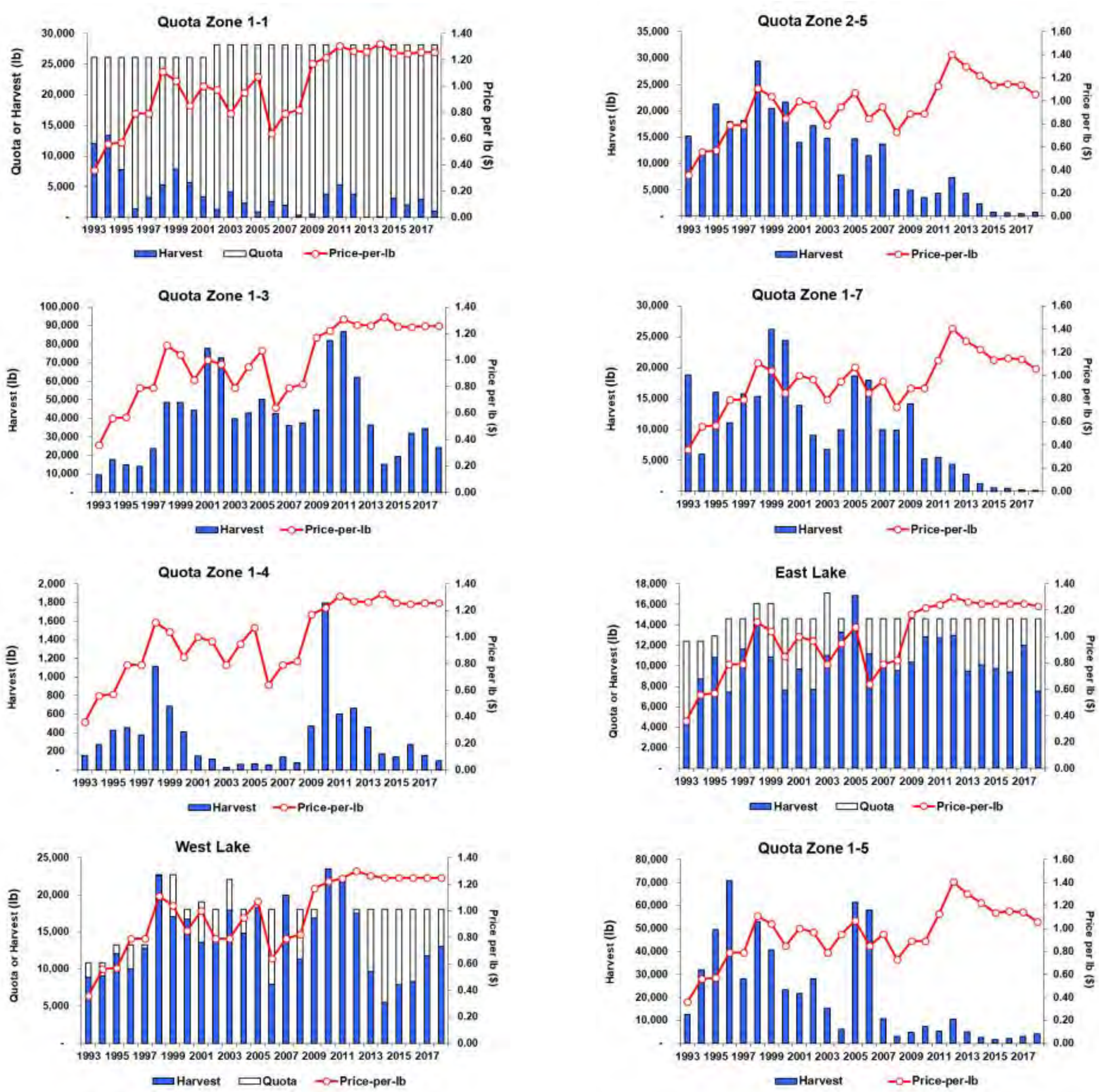


FIG. 3.2.15. Commercial base quota, harvest and price-per-lb for **Sunfish** in Quota Zones 1-1, 1-3, 1-4, 1-5, 2-5 and 1-7, East Lake and West Lake, 1993-2018.

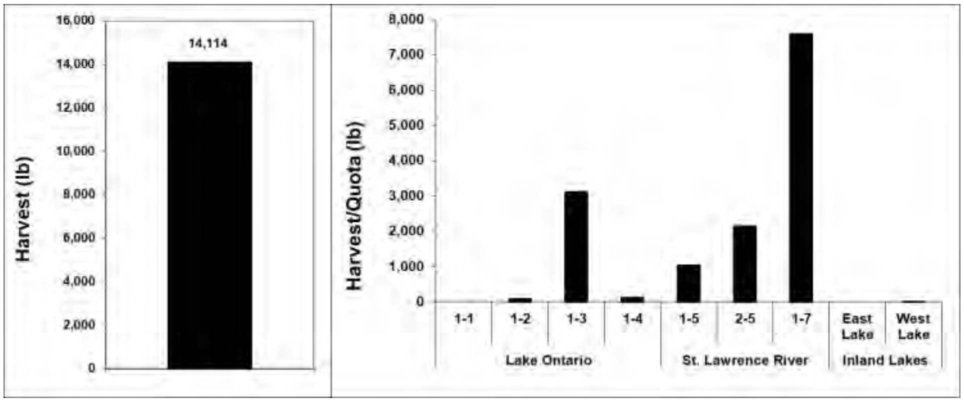


FIG. 3.2.16. **Brown Bullhead** commercial harvest by quota zone, 2018.

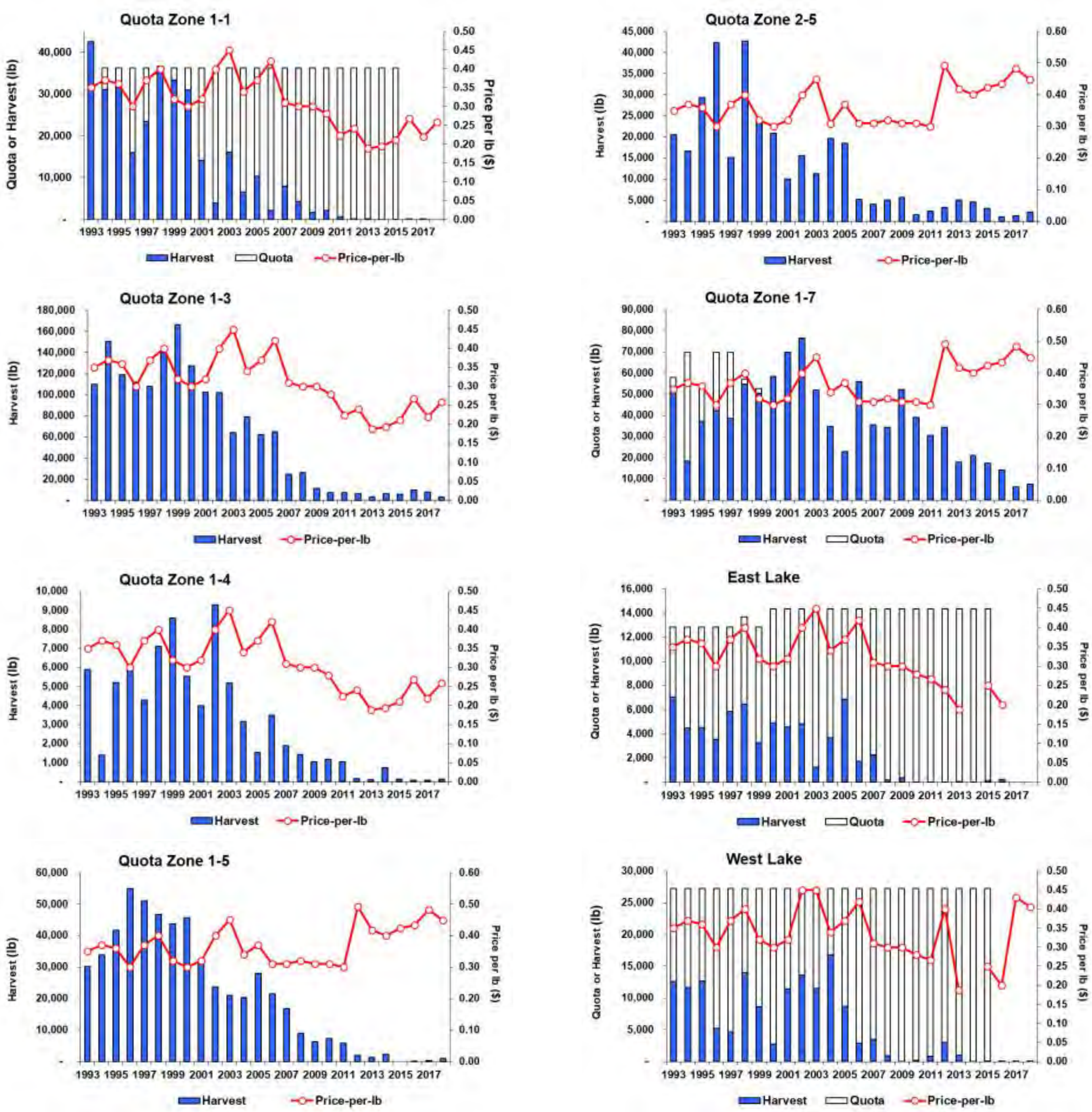


FIG. 3.2.17. Commercial base quota, harvest and price-per-lb for **Brown Bullhead** in Quota Zones 1-1, 1-3, 1-4, 1-5, 2-5 and 1-7, East Lake and West Lake, 1993-2018.

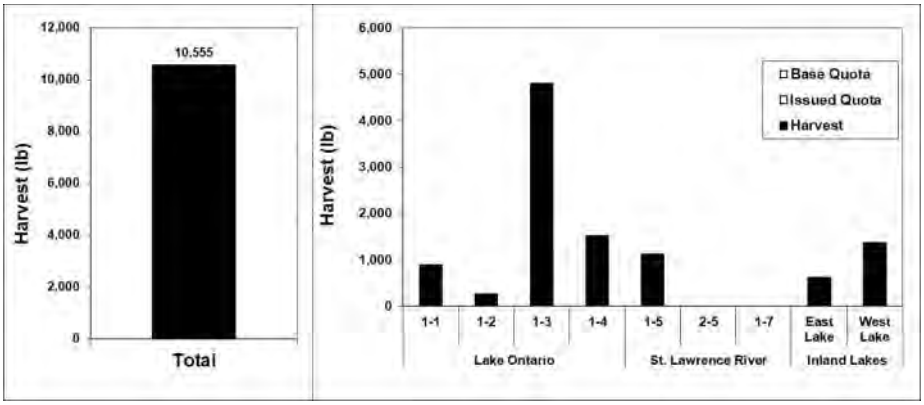


FIG. 3.2.18. **Northern Pike** commercial harvest by quota zone, 2018. In quota zones 2-5 and 1-7 no harvest is permitted; all other zones have unlimited quota.

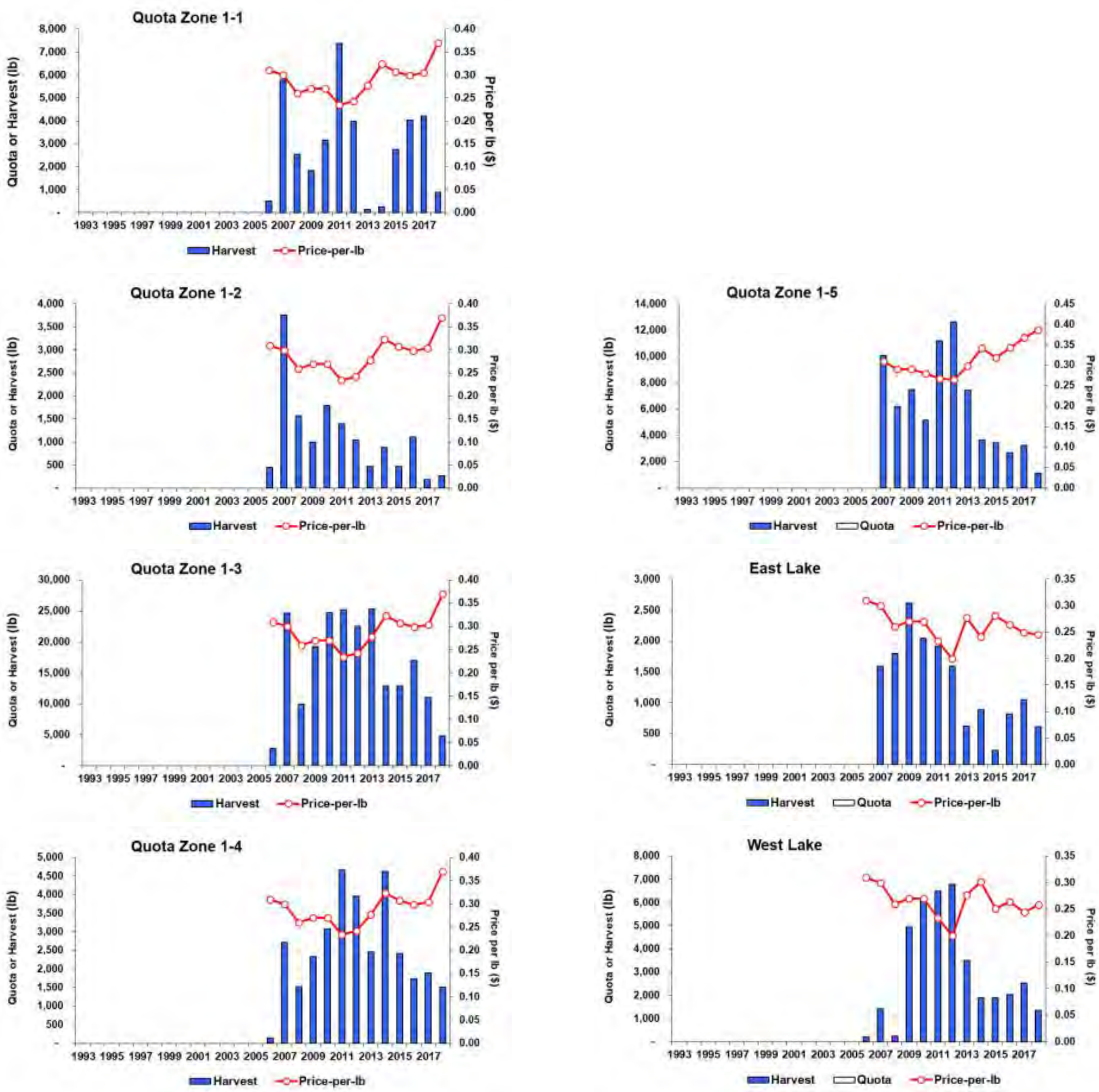


FIG. 3.2.19. Commercial base quota, harvest and price-per-lb for **Northern Pike** in Quota Zones 1-1, 1-2, 1-3, 1-4, and 1-5, East Lake and West Lake, 1993-2018.

3.3 Lake Whitefish Commercial Catch Sampling

J. A. Hoyle and E. Brown, Lake Ontario Management Unit

Biological sampling of commercially harvested Lake Whitefish is conducted annually. While total Lake Whitefish harvest can be determined from commercial fish Daily Catch Reports (DCRs; see Section 3.2), biological sampling of the catch is necessary to breakdown total harvest into size and age-specific harvest components.

Commercial Lake Whitefish harvest and fishing effort by gear type, month and quota zone for 2018 is reported in Table 3.3.1. Cumulative daily commercial Lake Whitefish harvest relative to quota 'milestones' is shown in Fig. 3.3.1. Total Lake Whitefish harvest for 2018 was 56,156 lbs; 44% of the issued quota and 42% of base quota.

Most of the harvest was taken in gill nets, 97% by weight; 3% of the harvest was taken in impoundment gear. Ninety-seven percent of the gill net harvest occurred in quota zone 1-2. Fifty-three percent of the gill net harvest in quota zone 1-2 was taken in November and December. In quota zone 1-3 most impoundment gear harvest and effort occurred in November (Table 3.3.1). Overall, about 26,000 lbs of Lake Whitefish were harvested before November 1, the date on which an additional 20% of base quota was made available to the "pool" (Fig 3.3.1).

Biological sampling focused on the November spawning-time gill net fishery on the south shore of Prince Edward County (quota zone 1-2), and the October/November spawning-time impoundment gear fishery in the Bay of Quinte (quota zone 1-3). The Lake Whitefish sampling design involves obtaining large numbers of length tally measurements and a smaller length-stratified sub-sample for more detailed biological sampling for the lake (quota zone 1-2) and bay (quota zone 1-3) spawning stocks. Whitefish length and age distribution information is presented in Fig. 3.3.2 and Fig. 3.3.3. In total, fork length was measured for 2,972 fish and age was interpreted using otoliths for 196 fish (Table 3.3.2, Fig. 3.3.2 and 3.3.3).

Lake Ontario Gill Net Fishery (quota zone 1-2)

The mean fork length and age of Lake Whitefish harvested during the gill net fishery in quota zone 1-2 were 477 mm and 10.1 years respectively (Fig. 3.3.2). Fish ranged from ages 4 -26 years. The most abundant age-classes in the

TABLE 3.3.1. Lake Whitefish harvest (lbs) and fishing effort (yards of gill net or number of impoundment nets) by gear type, month and quota zone. Harvest and effort value in ***bold italic*** represent months and quota zones where whitefish biological samples were collected.

		Harvest (lbs)			Effort (number of yards or nets)		
Gear type	Month	1-2	1-3	1-4	1-2	1-3	1-4
Gill net	Jan			12			80
	Apr	754			4,600		
	May	1,008			11,200		
	Jun	5,270			30,980		
	Jul	7,934			39,760		
	Aug	3,496			7,200		
	Sep	7,094		5	23,400		40
	Oct	59		16	400		80
	Nov	***25,807***		121	***30,180***		440
	Dec	2,775		10	7,160		40
Impoundment	Apr		8			14	
	May		14			21	
	Jun			3			4
	Oct		**252**	11		***149***	22
	Nov		***1,510***			***77***	

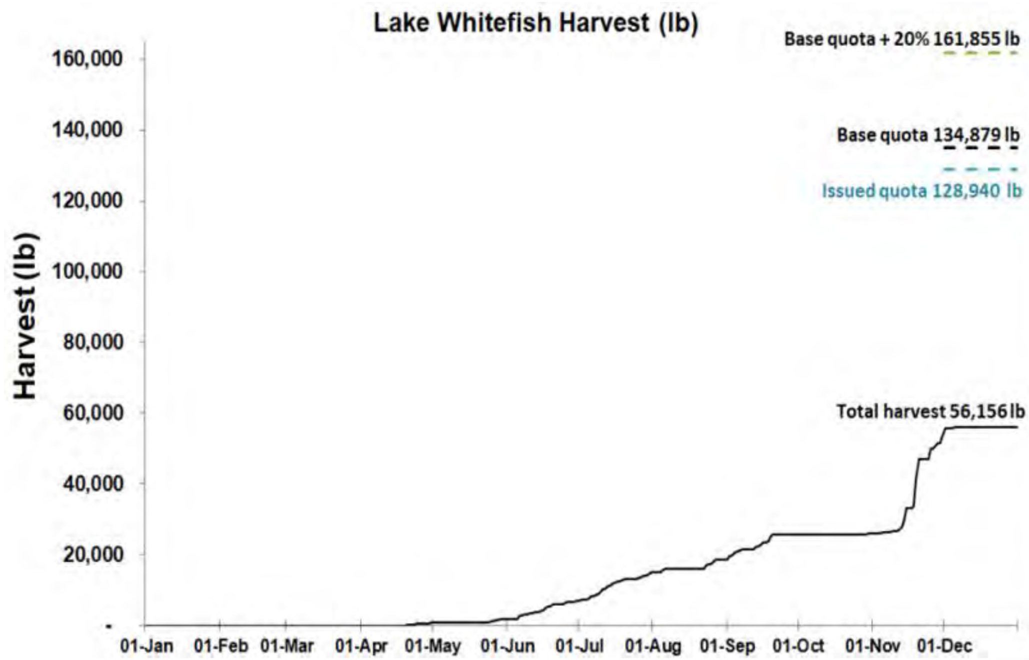


FIG. 3.3.1. Cumulative daily commercial Lake Whitefish harvest (2018) relative to quota 'milestones'.

TABLE 3.3.2. Age-specific vital statistics of Lake Whitefish sampled and harvested including number aged, number measured for length, and proportion by number of fish sampled, harvest by number and weight (kg), and mean weight (kg) and fork length (mm) of the harvest for quota zones 1-2 and 1-3, 2018

	Quota zone 1-2 (Lake stock)								Quota zone 1-3 (Bay stock)						
	Sampled			Harvested					Sampled			Harvested			
Age (years)	Number aged	Number lengthed	Proportion	Number	Weight (kg)	Mean weight (kg)	Mean length (mm)	Age (years)	Number aged	Number lengthed	Proportion	Number	Weight (kg)	Mean weight (kg)	Mean length (mm)
1	-	-	0.000	-	-			1	-	-	0.000	-	-		
2	-	-	0.000	-	-			2	-	-	0.000	-	-		
3	-	-	0.000	-	-			3	-	-	0.000	-	-		
4	2	22	0.008	165	173	1.051	446	4	6	19	0.073	52	49	0.936	438
5	9	117	0.043	862	713	0.827	419	5	17	44	0.169	121	108	0.899	435
6	17	396	0.146	2,912	2,945	1.011	447	6	10	30	0.115	82	96	1.168	462
7	4	100	0.037	735	772	1.050	448	7	6	16	0.060	43	51	1.189	469
8	26	765	0.282	5,627	6,311	1.122	459	8	3	10	0.037	26	22	0.839	429
9	2	51	0.019	378	476	1.260	492	9	6	14	0.055	39	45	1.148	478
10	4	184	0.068	1,354	1,865	1.378	501	10	20	56	0.214	153	163	1.067	464
11	1	26	0.009	189	221	1.171	493	11	6	14	0.053	38	44	1.159	481
12	17	519	0.191	3,819	5,570	1.459	505	12	9	16	0.060	43	53	1.237	489
13	8	259	0.095	1,902	2,606	1.370	489	13	7	14	0.054	39	60	1.546	521
14	10	113	0.042	829	1,376	1.661	527	14	4	7	0.027	19	34	1.771	540
15	1	35	0.013	255	356	1.396	519	15	4	9	0.036	26	34	1.297	494
16	-	-	0.000	-	-			16	-	-	0.000	-	-		
17	-	-	0.000	-	-			17	-	-	0.000	-	-		
18	-	-	0.000	-	-			18	-	-	0.000	-	-		
19	-	-	0.000	-	-			19	-	-	0.000	-	-		
20	-	-	0.000	-	-			20	-	-	0.000	-	-		
21	-	-	0.000	-	-			21	1	1	0.004	3	5	1.671	572
22	-	-	0.000	-	-			22	-	-	0.000	-	-		
23	-	-	0.000	-	-			23	-	-	0.000	-	-		
24	-	-	0.000	-	-			24	1	2	0.006	5	7	1.604	535
25	1	64	0.024	471	506	1.075	477	25	-	-	0.000	-	-		
26	9	61	0.023	450	694	1.541	541.7	26	-	-	0.000	-	-		
27	-	-	0.000	-	-			27	5	9	0.035	25	39	1.580	532
28	-	-	0.000	-	-			28	-	-	0.000	-	-		
29	-	-	0.000	-	-			29	-	-	0.000	-	-		
30	-	-	0.000	-	-			30	-	-	0.000	-	-		
31	-	-	0.000	-	-			31	-	-	0.000	-	-		
Total	111	2,712	1	19,946	24,583			Total	105	260	1	713	810		
Weighted mean						**1.233**		Weighted mean						**1.136**	

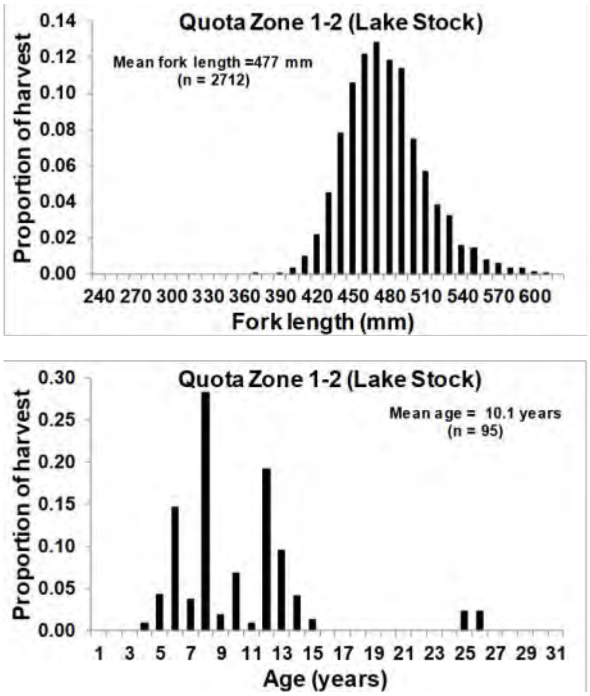


FIG. 3.3.2. Size and age distribution (by number) of Lake Whitefish sampled in quota zone 1-2 during the 2018 commercial catch sampling program

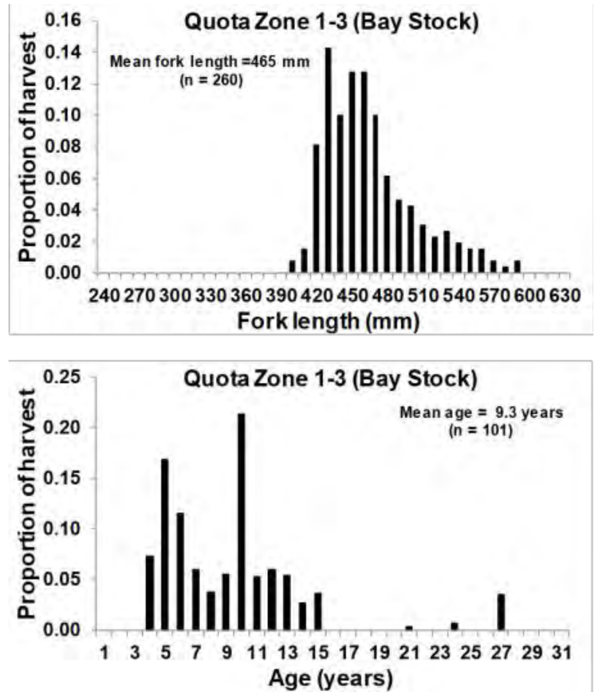


FIG. 3.3.3. Size and age distribution (by number) of Lake Whitefish sampled in quota zone 1-3 during the 2018 commercial catch sampling program.

fishery were aged 5-14 years which together comprised 93% of the harvest by number (93% by weight).

Bay of Quinte November Impoundment Gear Fishery (quota zone 1-3)

Mean fork length and age were 465 mm and 9.3 years, respectively (Fig. 3.3.3). Fish ranged from ages 4-27 years. The most abundant age-classes in the fishery were aged 4-15 years which together comprised 96% of the harvest by number (94% by weight).

Condition

Lake Whitefish (Bay of Quinte and Lake Ontario spawning stocks; sexes combined) relative weight (see Rennie et al. 2008[1]) is shown in Fig. 3.3.4. Condition declined markedly in 1994 and remained low but stable.

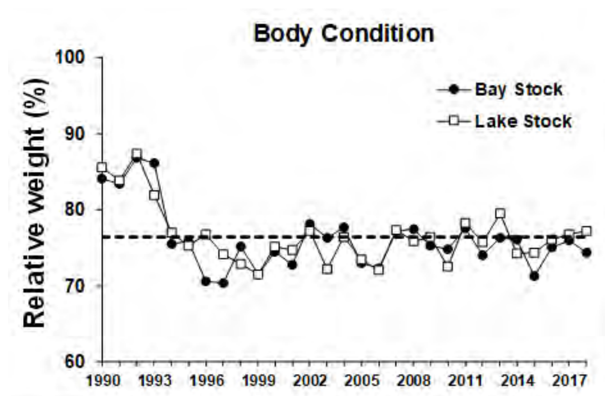


FIG. 3.3.4. Lake Whitefish (Lake Ontario and Bay of Quinte spawning stocks and sexes combined) relative weight (see [1]Rennie et al. 2008), 1990-2018.

[1]*Rennie, M.D. and R. Verdon. 2008. Development and evaluation of condition indices for the Lake Whitefish. N. Amer. J. Fish. Manage. 28:1270-1293.*

3.4 Cisco Commercial Catch Sampling

J. A. Hoyle and E. Brown, Lake Ontario Management Unit

Cisco appear to have increased in abundance in recent years (see Section 1.1 and 1.2). A small incidental commercial harvest of Cisco occurs in quota zone 1-3 where the species is taken in the fall Lake Whitefish targeted fishery. A sample of Cisco was taken in this fishery to examine size and age-class composition.

In total, fork length was measured for 849 fish and otoliths, for age interpretation, were collected for a sub-sample of 111 fish (Fig. 3.4.1). Age data were not available at the time of this report.

The mean fork length of Cisco harvested during the impoundment gear fishery in quota zone 1-3 was 344 mm (Fig. 3.4.1).

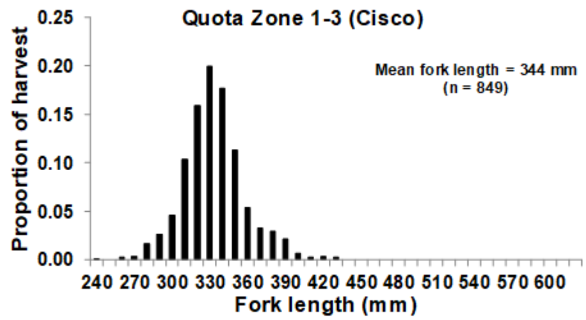


FIG. 3.4.1. Size distribution (by number) of Cisco sampled in quota zone 1-3 during the 2018 commercial catch sampling program.

4. Age and Growth Summary

S. Kranzl, J. A. Hoyle and E. Brown, Lake Ontario Management Unit

Biological sampling of fish from Lake Ontario Management Unit field projects routinely involves collecting and archiving structures used for such purposes as age interpretation and validation, origin determination (e.g. stocked versus wild), life history characteristics and other features of fish growth. Coded wire tags, embedded in the nose of fish prior to stocking, are sometimes employed to uniquely identify individual fish (e.g., to determine stocking location and year, when recovered). In 2018, a total of 3143 structures were processed from 12 different field projects (Table 4.1).

TABLE 4.1. Project-specific summary of age and growth structures interpreted for age (n=3143) in support of 12 different Lake Ontario Management Unit field projects, 2018 (CWT, Code Wire Tags).

Project	Species	Structure	n
Ganaraska Rainbow Trout Assessment			
	Rainbow Trout	Scales	136
	Atlantic Salmon	Scales	2
Lake Ontario and Bay of Quinte Community Index Gillnetting			
	Chinook Salmon	Otoliths	33
	Atlantic Salmon	Otoliths	2
	Brown Trout	Otoliths	87
	Lake Trout	Otoliths	256
	Lake Whitefish	Otoliths	32
	Cisco	Otoliths	117
	Walleye	Otoliths	826
	Lake Trout	CWT	95
Lake Ontario and Bay of Quinte Community Index Trawling			
	Walleye	Otoliths	4
	Walleye	Scales	45
Hamilton Harbour Nearshore Community Index Netting			
	Northern Pike	Cleithra	6
	White Bass	Scales	10
	Pumpkinseed	Scales	23
	Bluegill	Scales	39
	Smallmouth Bass	Scales	1
	Largemouth Bass	Scales	9
	Black Crappie	Scales	14
	Yellow Perch	Scales	10
	Walleye	Otoliths	24
Upper Bay of Quinte Nearshore Community Index Netting			
	Northern Pike	Cleithra	20
	Pumpkinseed	Scales	31
	Bluegill	Scales	36
	Smallmouth Bass	Scales	5
	Largemouth Bass	Scales	35
	Black Crappie	Scales	32
	Yellow Perch	Scales	35
	Walleye	Otoliths	31

TABLE 4.1. *continued.*

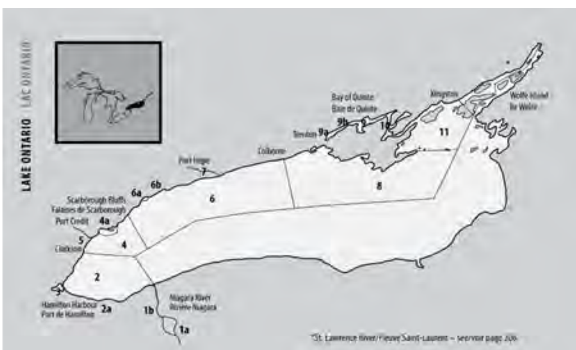
Toronto Waterfront Nearshore Community Index Netting			
	Northern Pike	Cleithra	21
	Pumpkinseed	Scales	30
	Bluegill	Scales	19
	Smallmouth Bass	Scales	2
	Largemouth Bass	Scales	13
	Black Crappie	Scales	2
	Yellow Perch	Scales	17
Lake St. Francis Community Index Netting			
	Northern Pike	Cleithra	5
	Smallmouth Bass	Scales	16
	Largemouth Bass	Scales	8
	Yellow Perch	Scales	110
	Walleye	Otoliths	39
Lake St. Francis Creel			
	Northern Pike	Scales	12
	Smallmouth Bass	Scales	39
	Largemouth Bass	Scales	20
	Yellow Perch	Scales	124
	Walleye	Scales	114
Credit River Chinook Assessment and Egg Collection			
	Chinook Salmon	Otoliths	130
	Atlantic Salmon	Scales	6
Ganaraska Chinook Assessment and Egg Collection			
	Chinook Salmon	Otoliths	94
	Atlantic Salmon	Scales	2
Commercial Catch Sampling			
	Lake Whitefish	Otoliths	196
	Cisco	Otoliths	111
Lake Ontario Chinook Salmon Tournament Sampling			
	Coho Salmon	CWT	15
	Lake Trout	CWT	2
Total			3143

5. Contaminant Monitoring

S. Kranzl, J. A. Hoyle and E. Brown, Lake Ontario Management Unit

Lake Ontario Management Unit (LOMU) cooperates annually with several agencies to collect fish samples for contaminant testing. In 2018, 256 contaminant samples were collected for Ontario's Ministry of the Environment, Conservation and Parks (MECP) Sport Fish Monitoring program (Table 5.1). Samples were primarily collected using existing fisheries assessment programs on Lake Ontario, Bay of Quinte and the St. Lawrence. Fig 5.1 is a map showing locations ("Blocks") for contaminant sample collections.

A summary of the number of fish samples collected by species, for contaminant analysis by the MECP from 2000 to 2018 is shown in Table 5.2.



3. **Hamilton Harbour** – harbour area
4. **Toronto Offshore Area** – open water from east of Clarkson Harbour to Scarborough Bluffs
4a.Toronto Waterfront Area – nearshore area from the west side of Humber Bay Park to the east side of Ashbridges Bay Park (including Toronto Islands)
6. Northwestern Lake Ontario – from east of Scarborough Bluffs to Colborne
7. Ganaraska River – from the river mouth to the Port Hope fish ladder
8. Northeastern Lake Ontario – from east of Colborne to south of the area from Main Duck Island across to Point Traverse
15. Lake St. Francis- St. Lawrence River from downstream of the Moses Saunders Dam to

FIG. 5.1. Map showing locations ("Blocks") for contaminant sample collections.

TABLE 5.1. Number of fish samples provided to MOECP for contaminant analysis, by region and species, 2018.

Region	Block	Species	Total
Hamilton Harbour	3	Bluegill	10
		Walleye	24
Toronto Offshore Area	4	Brown Trout	1
		Lake Trout	9
Toronto Waterfront Area	4a	Brown Bullhead	9
		Largemouth Bass	2
		Rock Bass	10
		White Perch	4
Northwestern Lake Ontario	6	Brown Trout	9
		Chinook Salmon	6
		Lake Trout	10
		Rainbow Smelt	2
		Rainbow Trout	2
Ganaraska River	7	Chinook Salmon	10
		Coho Salmon	10
Northeastern Lake Ontario	8	Brown Trout	10
		Chinook Salmon	5
		Lake Trout	10
		Lake Whitefish	10
		Rainbow Smelt	2
		Rock Bass	7
		Walleye	9
Lake St. Francis	15	Largemouth Bass	8
		Moxostoma sp.	4
		Northern Pike	5
		Shorthead Redhorse	1
		Silver Redhorse	4
		Smallmouth Bass	16
		Walleye	20
		White Sucker	16
		Yellow Perch	20
Total			256

TABLE 5.2. Summary of the number of fish samples collected, by species, for contaminant analysis by the MOECP, 2000 - 2018.

	Year																		
Species	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Black Crappie			20	20	3	20		20		20	29			35	2	14			
Bluegill		26		20	10	23			102	88		40	40	3		10			10
Brown Bullhead		40	44	40	25	30	33	40	68	63	56	81	34	78	53	52			9
Brown Trout	40	3	20		31		22	6	29	34	34	12	20	6	10	1			20
Channel Catfish	20	20	7	23		17				8		15	20	4	10			10	
Chinook Salmon	40	3	16		48		29	1	36		39	1	21	6	19	2			21
Cisco																18		20	
Coho Salmon		1	3																10
Common Carp				7													14	8	
Freshwater Drum			43		16		13	2	32	20	37			42	2		12	18	
Gizzard Shad																	7	10	
Lake Trout			42		54		38	17	46	20	33	13	18	20	49	10	28	10	29
Lake Whitefish	20													20	17	19	8	11	10
Largemouth Bass		4	25	28	20	9	8	89	26	40	28	55	20	11	7	18	20	4	10
Northern Pike		53	39	60	22	40	22	94	35	28	31	20	34	47	16	18	24	35	5
Pumpkinseed		60	25	57	8	11	23	78	92	105	19	43	31	14			15	20	
Rainbow Smelt																3			4
Rainbow Trout	40	37	28	20	37	20	29	20	21	20	33		1	22		20			2
Rock Bass		36	30	38	11	21	27	30	20	40	42	80	5	24			20	20	17
Silver Redhorse							1												9
Smallmouth Bass		20	87	22	21	28	35	23	39	40	31	58	15	19	20	20	25	37	16
Walleye		42	51	40	61	30	62	98	61	40	70	71	24	73	59	67	56	29	53
White Bass											20								
White Perch		40		40	40	14	21	20	35	20	7			40	8	11	4		4
White Sucker							1								25	7	21	30	16
Yellow Perch	20	60	66	58	75	40	86	90	60	91	80	20	44	81	22	20	39	50	20
Total	180	445	546	473	482	303	450	628	702	677	589	509	327	545	319	310	293	312	265

6. Stocking Program

6.1 Stocking Summary

C. Lake , Lake Ontario Management Unit

In 2018, OMNRF stocked over 2 million fish into Lake Ontario, equalling over 44,000 kilograms of biomass (Fig. 6.1.1; Table 6.1.1). Fish are allocated to one of seven sub-zones (Fig. 6.1.2) based on several factors, including: natural reproduction within the zone, angler demand and suitable available habitat. More detail on the stocking zones and fish allocation can be found in the Stocking Strategy for the Canadian Waters of Lake Ontario (2015). The St. Lawrence River is not stocked. Table 6.1.2 shows the 2018 stocking levels compared to the targets outlined in the 2015 strategy.

Figure 6.1.3 shows salmon and trout stocking trends in the Ontario waters of Lake Ontario for the most recent five years, broken

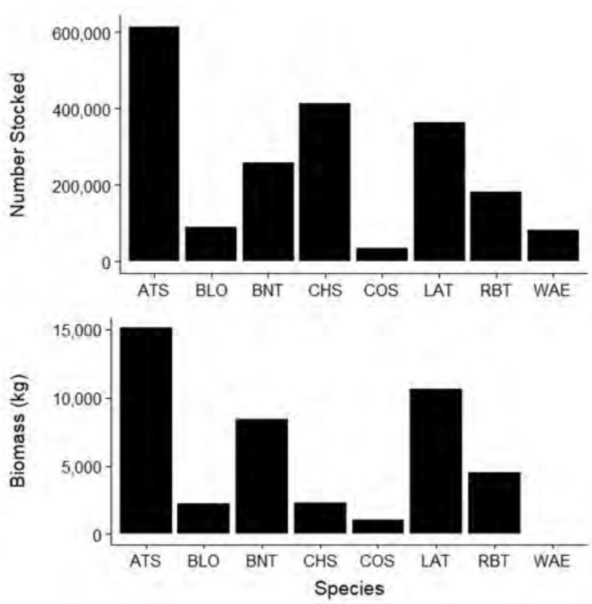


FIG. 6.1.1. **TOP:** Number of fish stocked into the Ontario waters of Lake Ontario in 2018 (total = 2,040,558). **BOTTOM:** Biomass of fish stocked into the Ontario waters of Lake Ontario in 2018 (total = 44,473 kg.). Egg and Non-feeding fry life stages not included in totals. ATS = Atlantic Salmon, BLO = Bloater, BNT = Brown Trout, CHS = Chinook Salmon, COS = Coho Salmon, LAT = Lake Trout, RBT = Rainbow Trout, WAE = Walleye.

TABLE 6.1.1. Fish stocked into the Ontario waters of Lake Ontario in 2018. Numbers reflect both MNRF-produced fish and those raised by community groups. Specific details can be found in Table 6.1.2.

Species	Lifestage	Number	Biomass (kg)
Atlantic Salmon	Egg [1]	79,881	8
	Spring Fingerling	352,851	1,137
	Fall Fingerling	129,704	4,305
	Spring Yearling	129,452	8,847
	Adult	416	853
	Atlantic Salmon Total	**612,423**	**15,141**
Bloater	Fall Yearling	50,552	1,053
	Sub Adult	41,101	1,165
	Bloater Total	**91,653**	**2,217**
Brown Trout	Spring Fingerling	50,000	100
	Fall Fingerling	30,000	600
	Spring Yearling	178,549	7,756
	Brown Trout Total:	**258,549**	**8,456**
Chinook Salmon	Spring Fingerling	**413,824**	**2,291**
Coho Salmon	Fall Fingerling	**36,000**	**1,080**
Lake Trout	Spring Yearling	**362,878**	**10,681**
Rainbow Trout	Spring Yearling	**183,055**	**4,556**
Walleye	Non-feeding Fry [1]	1,000,000	10
	Summer Fingerling	82,176	49
	Walleye Total:	**82,176**	**49**
TOTALS		**2,040,558**	**44,473**

[1] Egg and Non-feeding fry life stages not included in totals

TABLE 6.1.2. Fish stocked into the Ontario waters of Lake Ontario in 2018. Numbers reflect both MNRF-produced fish and those raised by community groups. Specific details can be found in Table 6.1.3.

Species	2018 Number	Strategy Target	Difference	% of Target
Atlantic Salmon	612,423	750,000	137,577	82%
Brown Trout	258,549	165,000	93,549	157%
Chinook Salmon	413,824	470,000	56,176	88%
Coho Salmon	36,000	80,000	44,000	45%
Bloater	91,653	250,000	158,347	37%
Lake Trout	362,878	352,000	10,878	103%
Rainbow Trout	183,055	140,000	43,055	131%
Walleye	82,176	100,000	17,824	82%
Totals	2,040,558	2,307,000	266,442	91%

down by species and stocking zone. Table 6.1.3 provides detailed information on fish stocking by species, location and life stage for 2018.

A total of 413,824 (2,291 kg) Chinook Salmon spring fingerlings were stocked to provide put-grow-and-take fishing opportunities. This was 88% of our new interim target of 470,000. The shortfall in 2018 was due to a loss of fish at the hatchery, and losses at two stocking net pen sites (see section 6.2 for a detailed report of the 2018 stocking net pen program). All Chinook Salmon for the Lake Ontario program were produced at Normandale Fish Culture Station. A total of 223,471 (54% of 2018 total) Chinook Salmon were held in stocking net pens for a short period of time prior to stocking.

Atlantic Salmon were stocked in support of an ongoing program to restore self-sustaining populations of this native species to the Lake Ontario basin (Section 8.2). In total, 612,423 (15,141 kg) Atlantic Salmon of several life stages were stocked in 2018 into tributaries including: Credit River, Duffins Creek and Cobourg Brook. Beginning in 2016, the Ganaraska River has been stocked with advanced life stages (spring yearlings and older), with the goal of establishing a fishery. Atlantic Salmon are produced at MNRF hatcheries, with some eggs being delivered to partner facilities for rearing. Stocking numbers for 2018 (all life stages combined) were 82% of target, however biomass (size of fish stocked) increased substantially.

A total of 362,878 (10,681 kg) Lake Trout spring yearlings were stocked in 2018 as part of an established, long-term rehabilitation program, supporting the Lake Trout Stocking Plan (Section 8.5). The 2018 target was held at a 20% reduction in response to poor Alewife year classes. The stocking level for 2018 was 103% of our stocking strategy target.

The total number of Bloater stocked in 2018 was 91,653 (2,217 kg.). This small relative of the Lake Whitefish was an important prey item for Lake Trout until the late 1950's when both species were extirpated. A coordinated program involving staff from the US and Canada resulted in the initial stocking of approximately 15,000 Bloater in 2013. MNRF Fish Culture Section staff continue to work with our partner agencies to advance our understanding of the complicated process of rearing Bloater. See Section 8.4 for a detailed description of this restoration effort.

Rainbow Trout (183,055; 4,556 kg) and Brown Trout (258,549; 8,456 kg) were stocked at various locations to support shore and boat fisheries. Community hatcheries contribute to the stocking of both species – see Table 6.1.3 for details. Coho Salmon were produced by stocking partner Metro East Anglers (approximately 36,000 fall fingerlings; 1,080 kg).

Walleye were stocked into Hamilton Harbour in 2018, continuing an effort to re-

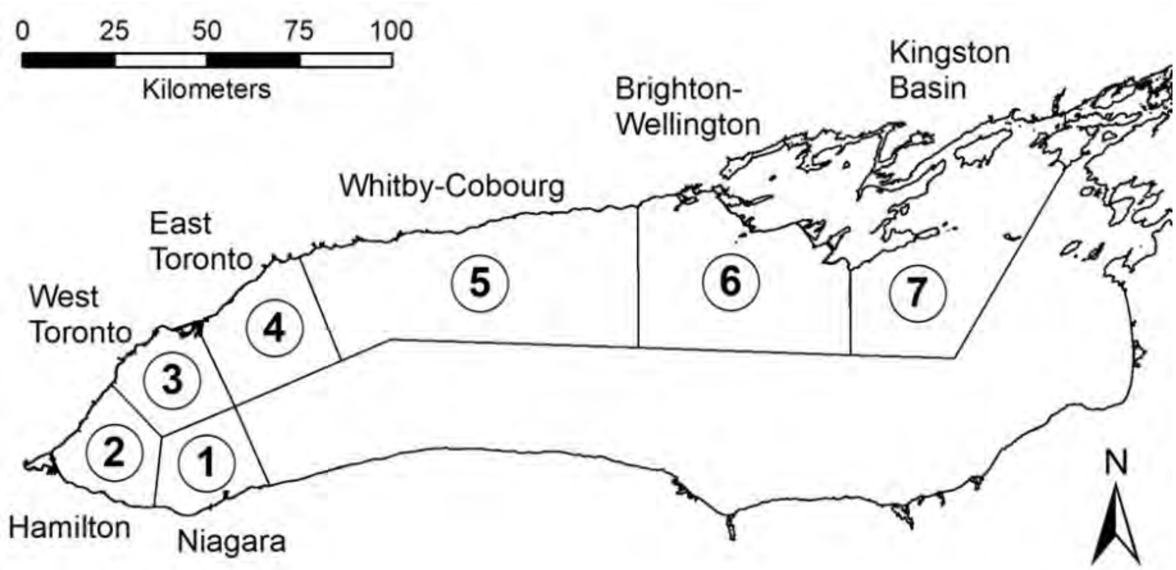


FIG. 6.1.2. Stocking zones for the Ontario waters of Lake Ontario. The zones were first developed for the Stocking Strategy for the Canadian Waters of Lake Ontario (2015).

establish this native, predatory fish to the fish community and to promote urban, near-shore angling (see section 8.6 of this report for more detail). Walleye stocking alternates annually between Toronto Harbour and Hamilton Harbour (even years in Hamilton). In 2018 Hamilton Harbour received approximately 1,000,000 Walleye non-feeding fry in the spring, followed by over 82,176 fingerlings stocked in July. A hot summer contributed to difficult rearing conditions in the hatchery outdoor ponds, but 82% of our target was still met.

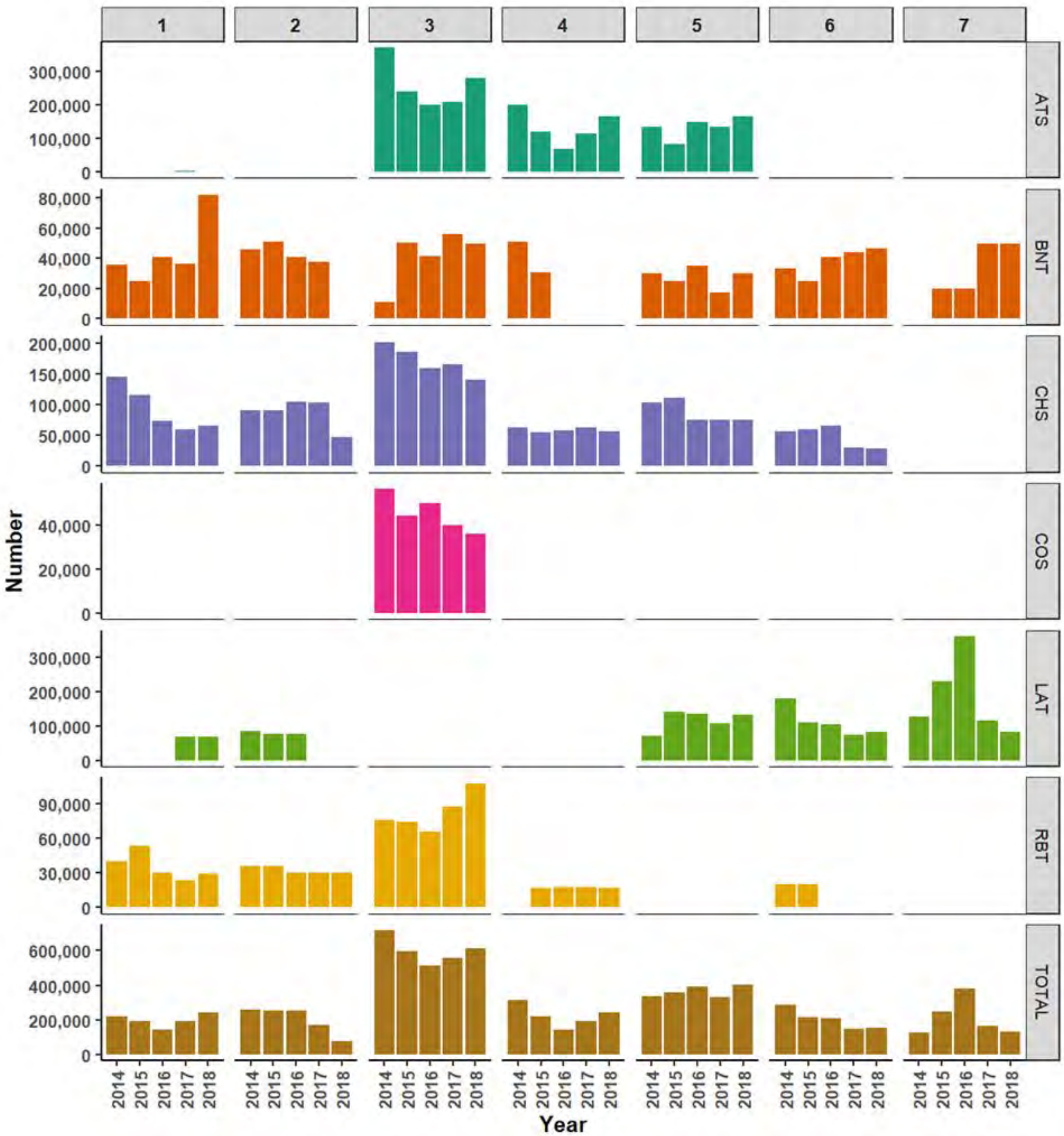


FIG. 6.1.3. Numbers of salmon and trout stocked in the Ontario waters of Lake Ontario for the most recent five years (2014-2018). Data are presented by species (rows) and by stocking zone (columns). The bottom panel ("Total") shows the total for all six species for the same time frame. ATS = Atlantic Salmon, BNT = Brown Trout, CHS = Chinook Salmon, COS = Coho Salmon, LAT = Lake Trout, RBT = Rainbow Trout. Note that the y-axes are variable.

TABLE 6.1.3. Fish stocked into the Ontario waters of Lake Ontario and its tributaries in 2018. Abbreviations defined at the bottom of the table.

Waterbody	Site	Hatchery	Strain	Marks	Month	Age	Wt. (g)	Biomass (kg)	Number
Atlantic Salmon - Egg									
Ganaraska R.	Ganaraska R.	MNRF-HW	LaHave	-	2	1	-	-	79,881
Atlantic Salmon - Spring Fingerling									
Cobourg Br.	Ball's Mill	MNRF-NM	Sebago	-	5	5	4.7	71	14,986
Cobourg Br.	Dale Rd.	MNRF-NM	LaHave	-	5	5	2.5	40	16,007
Cobourg Br.	Dale Rd.	MNRF-NM	Sebago	-	5	5	4.8	72	14,989
Cobourg Br.	Dale Rd.	SSFC	LaHave	-	6	4	1.2	12	10,412
Credit R.	Black Cr. - 15th Sideroad	MNRF-NM	Sebago	-	5	5	4.1	41	9,984
Credit R.	Black Cr. - 6th Line	MNRF-NM	LaHave	-	5	5	2.3	46	19,989
Credit R.	Ellie's Ice Cream Parlour	MNRF-NM	LaHave	-	6	5	3.7	46	12,323
Credit R.	Ellie's Ice Cream Parlour	MNRF-NM	Sebago	-	6	5	4.2	26	6,259
Credit R.	Forks - Dominion St.	MNRF-NM	Sebago	-	5	5	4.6	138	29,828
Credit R.	Forks - Meadow	MNRF-NM	Sebago	-	5	5	4.9	77	15,767
Credit R.	Forks - Stuck Truck	MNRF-NM	LaHave	-	5	5	3.8	60	15,998
Credit R.	Terra Cotta	MNRF-NM	LaHave	-	5	5	3.7	75	19,993
Credit R.	W.Credit - Belfountain	MNRF-NM	Sebago	-	5	5	4.4	66	14,995
Credit R.	W.Credit - Shaw's Creek Rd.	Belfountain	LaHave	-	5	5	0.2	1	6,200
Credit R.	W.Credit - Winston Churchill Blvd.	Belfountain	LaHave	-	5	5	0.2	2	6,650
Duffins Cr.	E.Duffins - 5th Conc.	MNRF-NM	LaHave	-	5	5	2.6	40	14,948
Duffins Cr.	E.Duffins - Claremont Field Centre	MNRF-NM	LaHave	-	6	5	3.4	86	24,990
Duffins Cr.	E.Duffins - Durham Outdoor Centre	MNRF-NM	LaHave	-	5	5	3.6	58	15,975
Duffins Cr.	E.Duffins - Pickering Museum	MNRF-NM	Sebago	-	5	5	4.8	73	15,197
Duffins Cr.	W.Duffins - Green River	SSFC	LaHave	-	5	4	1.2	37	30,785
Duffins Cr.	W.Duffins - Sideline 32	MNRF-NM	Sebago	-	5	5	4.5	68	15,144
Humber R.	Coffey Cr. - Coffey Cr. Farm	Islington	LaHave	-	5	4	0.1	1	9,347
Humber R.	Coffey Cr. - Markoff Property	Islington	LaHave	-	5	4	0.2	1	6,667
Humber R.	Humber Station Rd.	Islington	LaHave	-	5	4	0.2	1	5,418
Atlantic Salmon - Fall Fingerling									
Cobourg Br.	Danforth Rd.	MNRF-NM	LaHave	-	9	10	27.6	398	14,404
Cobourg Br.	Division St.	MNRF-NM	LaHave	-	9	10	38.8	388	10,004
Credit R.	Eldorado Park	MNRF-NM	LaHave	-	10	10	31.2	824	21,533
Credit R.	McLaughlin Rd. Bridge	MNRF-NM	LaHave	-	10	10	18.9	284	15,011
Credit R.	Norval Nashville North	MNRF-NM	LaHave	-	10	10	33.4	439	10,223
Credit R.	Terra Cotta	MNRF-NM	LaHave	-	10	10	20.9	314	14,996
Duffins Cr.	E.Duffins - 5th Conc.	MNRF-NM	LaHave	-	10	10	47.6	568	15,472
Duffins Cr.	W.Duffins - Sideline 28 - Wixon Cr.	MNRF-NM	LaHave	-	9	10	23.9	358	15,006
Shelter Valley	Skyview Rd.	MNRF-NM	LaHave	-	10	10	56.1	732	13,055
Atlantic Salmon - Spring Yearling									
Cobourg Br.	Division St.	MNRF-NM	LaHave	-	3	15	73.7	332	4,507
Cobourg Br.	Division St.	MNRF-NM	Sebago	-	3	16	64	88	1,370
Cobourg Br.	West Branch - Telephone Road	MNRF-NM	LaHave	-	4	16	79.6	196	2,467
Cobourg Br.	West Branch - Telephone Road	MNRF-NM	Sebago	-	4	16	79.7	828	9,906
Credit R.	Grange Sideroad	MNRF-NM	LaHave	-	3	15	61.4	557	9,186
Credit R.	Inglewood	MNRF-NM	Sebago	-	3	16	61.9	581	9,495
Credit R.	Norval Nashville North	MNRF-NM	LaHave	-	3	14	64.7	645	9,823
Credit R.	Terra Cotta	MNRF-NM	Sebago	-	3	16	63.3	620	9,831
Duffins Cr.	E.Duffins - 5th Conc.	MNRF-NM	LaHave	-	3	15	74.4	506	6,770
Duffins Cr.	E.Duffins - 5th Conc.	MNRF-NM	Sebago	-	3	16	66.9	473	7,028
Duffins Cr.	E.Duffins - Paulynn Park	MNRF-NM	Sebago	-	3	16	72	401	5,573
Ganaraska R.	Newtonville Rd.	MEA	LaHave	AD	4	14	75	777	10,365
Ganaraska R.	Newtonville Rd.	MEA	Sebago	AD	3	15	75	855	11,400
Ganaraska R.	Shiloh Rd.	MNRF-NM	Sebago	AD	3	16	65.5	1,644	24,997
Shelter Valley	Skyview Rd.	MNRF-NM	Sebago	AD	2	14	50.2	344	6,734
Atlantic Salmon - Adult									
Lake Ontario	Bronte Hrbr.	MNRF-NM	Sebago	FLOY	11	35	2050	402	196
Lake Ontario	Port Dalhousie East	MNRF-NM	Sebago	FLOY	12	35	2050	451	220

Continued on next page

TABLE 6.1.3. Fish stocked into the Ontario waters of Lake Ontario and its tributaries in 2018. Abbreviations defined at the bottom of the table.

Waterbody	Site	Hatchery	Strain	Marks	Month	Age	Wt. (g)	Biomass (kg)	Number
Bloater - Fall Yearling									
Lake Ontario	Cobourg - 100	MNRF-CH	Lk.Mich.	-	11	19	20.5	765	37,369
Lake Ontario	Cobourg - 100	MNRF-HW	Lk.Mich.	-	11	18	21	217	10,333
Lake Ontario	Finkle's Shore Ramp	MNRF-WL	Lk.Mich.	-	9	19	24.6	70	2,850
Bloater - Sub Adult									
Lake Ontario	Cobourg Hrbr. Pier	MNRF-WL	Lk.Mich.	-	11	20	34	895	31,004
Lake Ontario	Main Duck Isl.	MNRF-WL	Lk.Mich.	-	5	26	36	39	1,074
Lake Ontario	North of Main Duck Sill	MNRF-WL	Lk.Mich.	-	11	20	25.6	231	9,023
Brown Trout - Spring Fingerling									
Lake Ontario	Finkle's Shore Ramp	Springside	Ganaraska	-	6	6	2	100	50,000
Brown Trout - Fall Fingerling									
Lake Ontario	Port Darlington	MEA	Ganaraska	-	11	10	20	600	30,000
Brown Trout - Spring Yearling									
Credit R.	Norval	CRAA	Ganaraska	-	6	16	34.8	22	638
Lake Ontario	Athol Bay	MNRF-CH	Ganaraska	-	3	16	46.9	2,180	46,512
Lake Ontario	Humber Bay Park	MNRF-CH	Ganaraska	-	3	16	41	839	20,468
Lake Ontario	Jordan Hrbr.	MNRF-CH	Ganaraska	-	3	16	42.8	1,760	41,072
Lake Ontario	Lakefront Promenade	MNRF-CH	Ganaraska	-	3	16	43.2	1,220	28,844
Lake Ontario	Port Dalhousie East	MNRF-CH	Ganaraska	-	3	16	42.3	1,735	41,015
Chinook Salmon - Spring Fingerling									
Bronte Cr.	2nd Side Road Bridge	MNRF-NM	Lk.Ont.	-	5	6	4.8	81	17,013
Bronte Cr.	4th Side Road Bridge	MNRF-NM	Lk.Ont.	-	5	6	4.8	98	20,478
Credit R.	Eldorado Park	MNRF-NM	Ganaraska	AD	5	6	4.7	139	29,687
Credit R.	Eldorado Park	MNRF-NM	Lk.Ont.	-	5	6	4.5	171	37,637
Credit R.	Norval Nashville North	MNRF-NM	Ganaraska	AD	5	6	4.6	341	73,538
Highland Cr.	Colonel Danforth Park	MNRF-NM	Lk.Ont.	-	5	6	5.6	67	12,000
Lake Ontario	Bluffers Park - Netpen	MNRF-NM	Lk.Ont.	-	5	5	6.1	275	45,023
Lake Ontario	Bronte Hrbr. - Netpen	MNRF-NM	Lk.Ont.	-	4	5	3.3	32	9,569
Lake Ontario	Oshawa Hrbr. - Netpen	MNRF-NM	Lk.Ont.	-	5	5	5.8	144	25,058
Lake Ontario	Port Dalhousie - Netpen	MNRF-NM	Lk.Ont.	-	5	5	5.9	385	65,261
Lake Ontario	Wellington - Netpen	MNRF-NM	Lk.Ont.	-	5	5	7.7	220	28,562
Lake Ontario	Whitby Hrbr. - Netpen	MNRF-NM	Lk.Ont.	-	5	5	6.8	338	49,998
Coho Salmon - Fall Fingerling									
Credit R.	Norval	MEA	Lk.Ont.	AD	10	10	30	1,080	36,000
Lake Trout - Spring Yearling									
Lake Ontario	Athol Bay	MNRF-NB	Seneca	LVAD	4	16	22.4	1,866	80,921
Lake Ontario	Beacon Inn	MNRF-HW	Seneca	LVAD	4	15	48.6	3,251	67,731
Lake Ontario	Cobourg Hrbr. Pier	MNRF-NB	Slate	LVAD	4	16	23.2	1,450	61,748
Lake Ontario	Finkle's Shore Ramp	MNRF-WL	Seneca	LVAD	4	16	32	2,590	80,950
Lake Ontario	Lakeport	MNRF-NB	Seneca	LVAD	4	16	21.4	1,525	71,528
Rainbow Trout - Spring Yearling									
Bronte Cr.	2nd Side Road Bridge	MNRF-HW	Ganaraska	-	5	14	26.1	391	15,000
Bronte Cr.	4th Side Road Bridge	MNRF-HW	Ganaraska	-	5	14	28.9	434	15,000
Credit R.	Eldorado Park	MNRF-HW	Ganaraska	-	6	15	28.9	773	26,745
Credit R.	Norval	CRAA	Lk.Ont.	-	6	12	13.3	246	18,522
Credit R.	Norval	MNRF-HW	Ganaraska	-	5	14	25.6	640	25,016
Humber R.	East Branch Islington	MNRF-HW	Ganaraska	-	5	14	23.7	355	14,978
Humber R.	King Vaughan Line	MNRF-HW	Ganaraska	-	6	14	31.8	707	22,156
Lake Ontario	Port Dalhousie East	MNRF-HW	Ganaraska	-	4	14	26.4	764	29,238
Rouge R.	Little Rouge R. Steeles	MEA	Ganaraska	-	5	12	15	246	16,400
Walleye - Non-feeding Fry									
Hamilton Hrbr.	Fisherman's Pier	MNRF-WL	Quinte	-	5	1	0	10	1,000,000
Walleye - Summer Fingerling									
Hamilton Hrbr.	Pier 4 Park	MNRF-WL	Quinte	-	7	3	0.6	49	82,176

MNRF Fish Culture Stations: CH = Chatsworth, HW = Harwood, NM = Normandale, NB = North Bay, WL = White Lake.
Volunteer and other hatcheries: Belfountain = Belfountain Hatchery, CRAA = Credit River Anglers Association, Islington = Islington Sportsman Club, MEA = Metro East Anglers (Ringwood), SSFC = Sir Sandford Fleming College Hatchery, Springside = Springside Park Hatchery

6.2 Chinook Salmon Net Pen Imprinting Project

C. Lake, Lake Ontario Management Unit

The stocking net pen is a floating enclosure that is tied to a pier or other nearshore structure and is used to temporarily house and acclimatize young Chinook Salmon prior to their release into Lake Ontario. The fish are held in the net pen for approximately 4-5 weeks, and the sites are managed by local angler groups who monitor the health of the fish and ensure that the fish are fed, and the pens are cleaned regularly. Several of the clubs also use the net pens as an outreach tool, involving their local community during delivery and/or release of the fish.

Compared to fish released directly from the hatchery, net pen fish are larger, survive better and may have a greater degree of site fidelity, or imprinting, to the stocking site based on marking experiments conducted by the New York Department of Environmental Conservation (NYSDEC). Because of their time in the net pens as young fish, it is expected that sexually mature fish will return to the area and provide a quality near shore fall fishery for anglers. A thorough review of the history of the program was described in the 2014 Annual Report.

2018 Net Pen Program

A total of 223,471 Chinook Salmon were released from 6 sites (18 net pens) in 2018. This represents 54% of the total number (413,824) of Chinook Salmon stocked in the Ontario waters of Lake Ontario in 2018 (Fig. 6.2.1). 2018 was a challenging year for the net pen program. One site (Port Darlington) was not used to due safety concerns relating to dock maintenance and volunteer access to the net pens. The two pens from Darlington were transferred to Port Whitby for the 2018 season, which had four pens as a result. Site-specific data for the 2018 season is shown in Table 6.2.1.

Major fish mortality events were experienced at two sites (Port Credit – 100% loss; Bronte Harbour – 68% loss, and early release of the remaining fish). The mortality events occurred immediately after a severe 3-day, lake-wide storm that may have impacted the fish in a variety of ways, including stirring up sediments and increasing turbidity and/or stressing fish due to storm surge and rapid temperature fluctuations. The mortality events occurred at Port Credit and Bronte approximately 10-11 days after fish were delivered. Dead and dying fish were collected from Bronte shortly after the mortality event by LOMU staff and sent to the University of Guelph - OVC Pathobiology & Animal Health Laboratory. Unfortunately, the samples were not in good enough condition to permit analysis. The net pen committee (led by MNRF LOMU) will review the year's events and will develop some mitigative measures for use in the program moving forward.

TABLE. 6.2.1. Summary data of the 2018 Chinook Salmon stocking net pen program. Note that Port Darlington was not used in 2018, and major mortality events occurred at Port Credit and Bronte Harbour. * CLOSA (Central Lake Ontario Salmon Anglers); HRSTA (Halton Region Salmon and Trout Assoc.); MEA (Metro East Anglers); PCSTA (Port Credit Salmon & Trout Assoc.); SCFGC (St. Catharines Fish & Game Club)

Site	Club*	Number Stocked	# Net Pens	Stocking Date	Size (g) at stocking	Release Date	# Days	Release size (g)	Mort. (# fish)	Mortality (%)	Samples Taken	Number Released
Bluffers	MEA	45,043	3	Apr - 08	2.7	May - 15	38	6.1	-	0%	20	45,023
Bronte	HRSTA	30,069	2	Apr - 07	2.6	Apr - 18	12	3.3	20,480	68%	20	9,569
Credit	PCSTA	10,055	1	Apr - 07	2.6	-	-	-	10,055	100%	0	-
Dalhousie	SCFGC	65,281	4	Apr - 09	3.0	May - 11	33	5.9	-	0%	20	65,261
Darlington	MEA	-	0	-	-	-	-	-	-	-	-	-
Oshawa	MEA	25,078	2	Apr - 03	2.8	May - 11	39	5.8	-	0%	20	25,058
Wellington	CLOSA	30,127	2	Apr - 03	2.8	May - 08	36	5.6	1,515	5%	50	28,562
Whitby	MEA	50,018	4	Apr - 08	2.9	May - 12	35	6.8	-	0%	20	49,998
Average		31,959			2.8		32	5.6			21	31,924
Total		255,671	18						32,050		150	223,471

Aside from the mortality events at Bronte and Port Credit, survival was good at the other sites, but growth was slower than normal due to a cold spring. As a result, fish were held slightly longer than average (32 days for 2018; long-term average is 30.5 days; see Fig. 6.2.2). Fish were delivered to the pens at 2.8 g and weighed 5.6 g when released (Fig. 6.2.3).

The smaller size of fish in 2018 kept overall density in each pen low. A maximum of 15,000 fish are placed in each net pen, keeping the overall density under the guideline of 32g of fish per liter of water (net pens are ~ 4,000 litres, and we assume max size per fish is 8g at release). Figure 6.2.4 shows the average density of fish (at time of release) in the net pens, with the guideline (32 g/l) denoted by the horizontal dotted line.

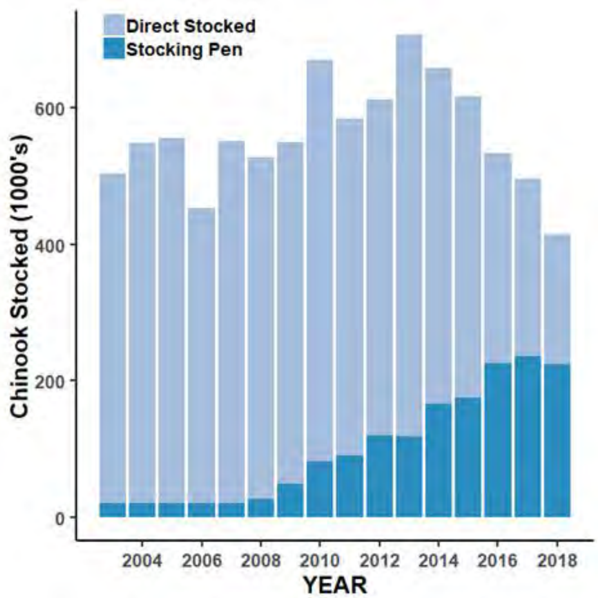


FIG. 6.2.1. Number of Chinook Salmon released (2003-2018) from Ontario net pens versus those stocked directly.

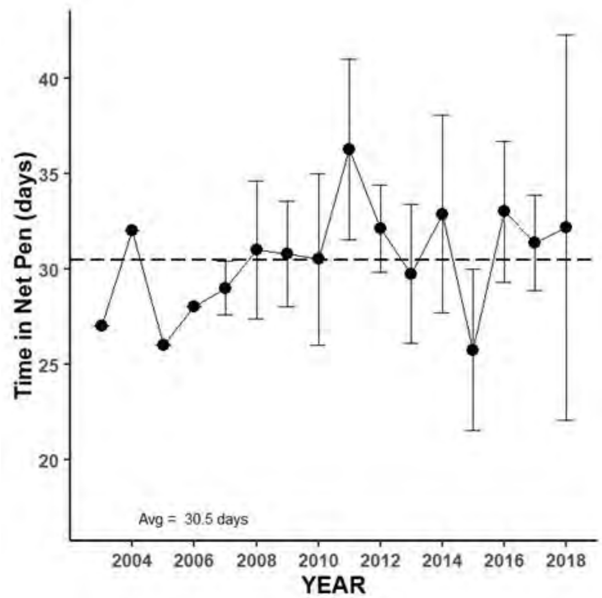


FIG. 6.2.2. Average duration of the stocking net pen program for 2018 (note: early release of fish at Bronte in 2018).

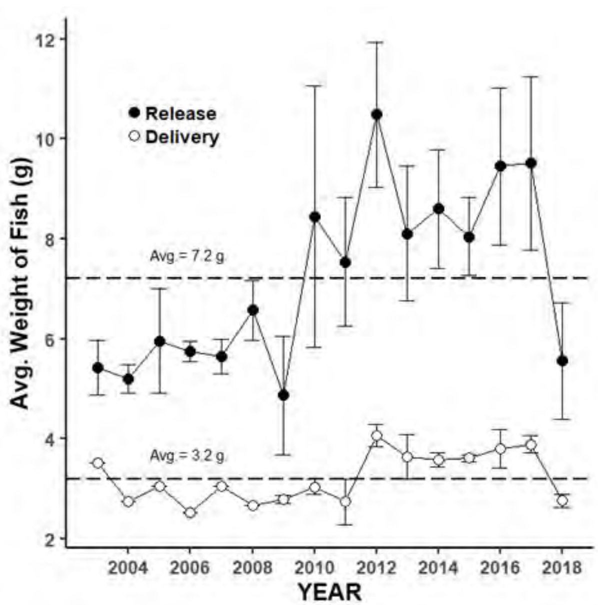


FIG. 6.2.3. Average weight (g) of fish when delivered to the net pens and at time of release. Average weight represented by the dashed lines.

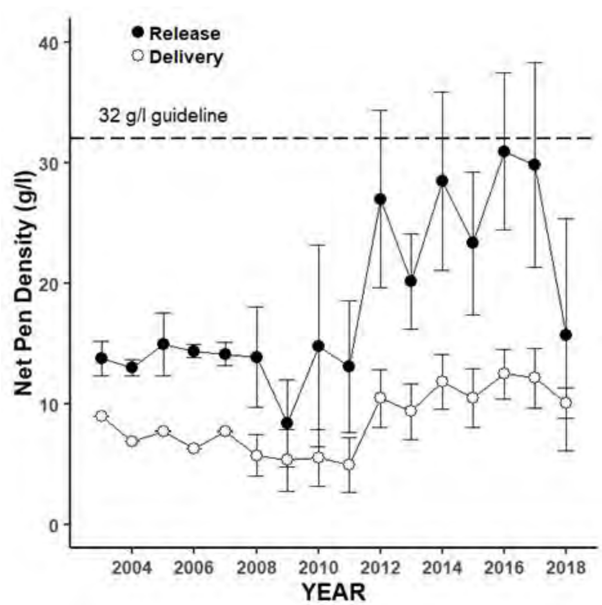


FIG. 6.2.4. Average density (g/l) of Chinook Salmon held per stocking net pen. The guideline is represented by the dashed line.

7. Stock Status

7.1 Chinook Salmon

M. J. Yuille, Lake Ontario Management Unit

Chinook salmon were stocked in Lake Ontario beginning in 1968 to suppress an over-abundant Alewife population, provide a recreational fishery and restore predator-prey balance to the fish community. At present Chinook Salmon are the most sought-after species in the main basin recreational fishery, which is supported by a mix of New York State and Ontario stocked as well as naturalized fish. Salmon returning to rivers to spawn also support important shore and tributary fisheries. Data presented in the following paragraphs represent programs led by the Lake Ontario Management Unit (LOMU). Future Chinook Salmon stock status summaries will synthesize data and analyses from both LOMU and New York State Department of Environment and Conservation (NYSDEC) to provide a holistic evaluation of the Lake Ontario Chinook Salmon population.

Ontario's Chinook Salmon stocking levels have remained relatively constant since 1985 (approximately 500,000 to 600,000 per year; Fig. 7.1.1). Ontario's current based stocking target is 600k Chinook Salmon annually. New York State Chinook Salmon stocking peaked in the early 1980s at over 3.5 million fish; their target was reduced in 1996 to the current base target of approximately 1.76 million fish. In 2017, lake-wide Chinook stocking targets were reduced 20% and remained at the reduced level for 2018 resulting in a new reduced target for Ontario of 480,000 Chinook Salmon. In 2018, due to unexpected mortalities in the hatchery and stocking net pens (Section 6.1) the actual number stocked was 413,824. Despite recent stable stocking levels, Chinook Salmon CUE in the Fish Community Index Gill Netting has been variable. Catches in 2018 (0.18 fish per net) increased from 2017 (0.13 fish per net) and are comparable to the previous 10-year average (0.16 fish per net from 2008 to 2017; Fig. 7.1.2).

Chinook Salmon mark and tag monitoring data were reported from five LOMU surveys: i) Western Lake Ontario Boat Angling Survey (Section 2.2 of 2016 Annual Report), ii) Chinook Salmon Angling Tournament and Derby Sampling (Section 2.4), iii) Lake Ontario Volunteer Angler Diary Program (Section 2.3 of 2016 Annual Report), iv) Eastern Lake Ontario and Bay of Quinte Fish Community Index Gill Netting (Section 1.1) and v) Credit River Chinook Salmon Spawning Index (Section 1.5). Community Index Gill Netting (Section 1.1) catches small Chinook Salmon and complements the angler-based programs that catch larger fish (Fig. 7.1.3).

2016 marked the end of the Chinook Salmon coded wire tag (CWT) study. In general, the maximum age of a Lake Ontario Chinook

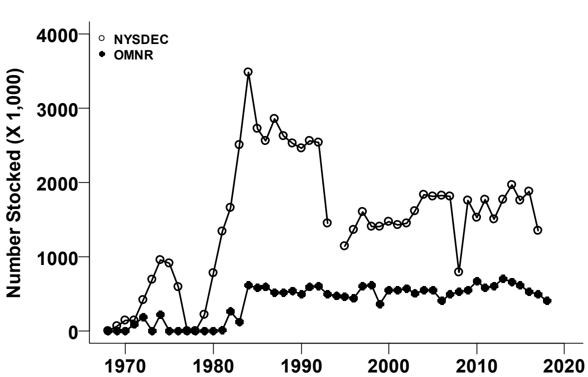


FIG. 7.1.1 Number of Chinook Salmon stocked by New York State Department of Environmental Conservation (NYSDEC) and OMNRF from 1968 – 2018 (Section 6.1).

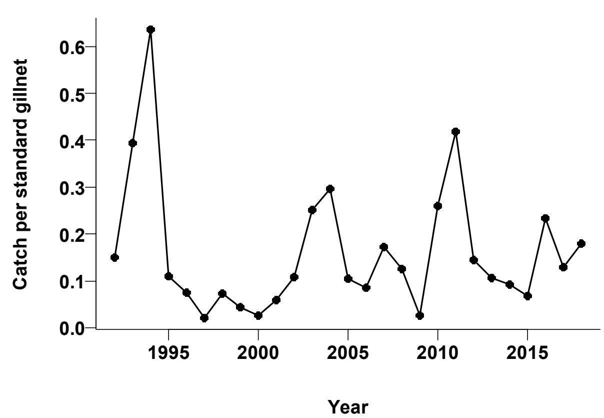


FIG. 7.1.2. Number of Chinook Salmon caught per gill net (CUE) from the Fish Community Index Gill Netting Program (see Section 1.2) from 1992 – 2018.

Salmon is 4 years old. The last stocking event related to the Mark and Tag program was in 2011, thus all fish associated with this program left the Lake Ontario ecosystem in the fall of 2015. CWTs were collected from the Chinook Salmon Mark and Tag program from 2009 to 2015 and have shown a mixed population of Chinook Salmon (natural reproduced, stocked by New York and stocked by Ontario) originating from geographically widespread stocking locations. The mark and tag monitoring program has confirmed that Chinook Salmon returns to the Credit River tend to originate from fish stocked in the Credit River with a few strays from Bronte Creek stocking locations.

The Lake Ontario Management Unit continued to collect Chinook Salmon on the Ganaraska River in 2018 with the goal of diversifying Chinook Salmon gamete sources. In contrast to the Credit River, where adult returns are predominantly stocked fish, adult Chinook Salmon returning to the Ganaraska River to spawn are naturalized. Chinook Salmon stocked by LOMU into the Credit River that originated from the Ganaraska River Egg Collection (Sections 1.4, 1.5 and 6.1) received an adipose clip prior to stocking. LOMU started collecting Chinook Salmon gametes on the Ganaraska River in 2015 and the first stocking event on the Credit River using these fish was in the spring of 2016 (Section 6.1). Over the next few years, LOMU will be using data collected from both the Credit River Riverwatcher fish counter and the annual Chinook Salmon Spawning Index (Section 1.5) to evaluate the performance of both egg sources (e.g., return percentage, run timing, age and size at maturity, etc).

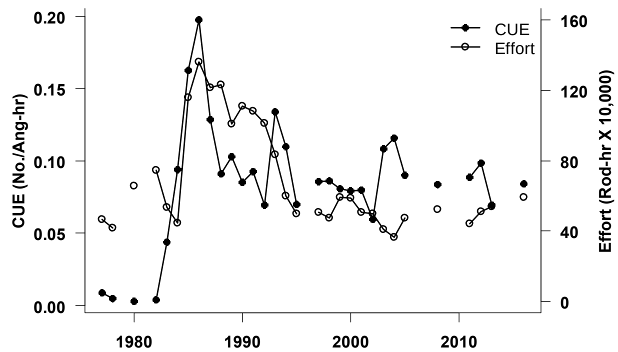


FIG. 7.1.4. Catch rate (CUE) of Chinook Salmon and annual total effort (rod-hrs) in the Ontario waters of Lake Ontario (excluding the Eastern Basin), 1977 to 2016.

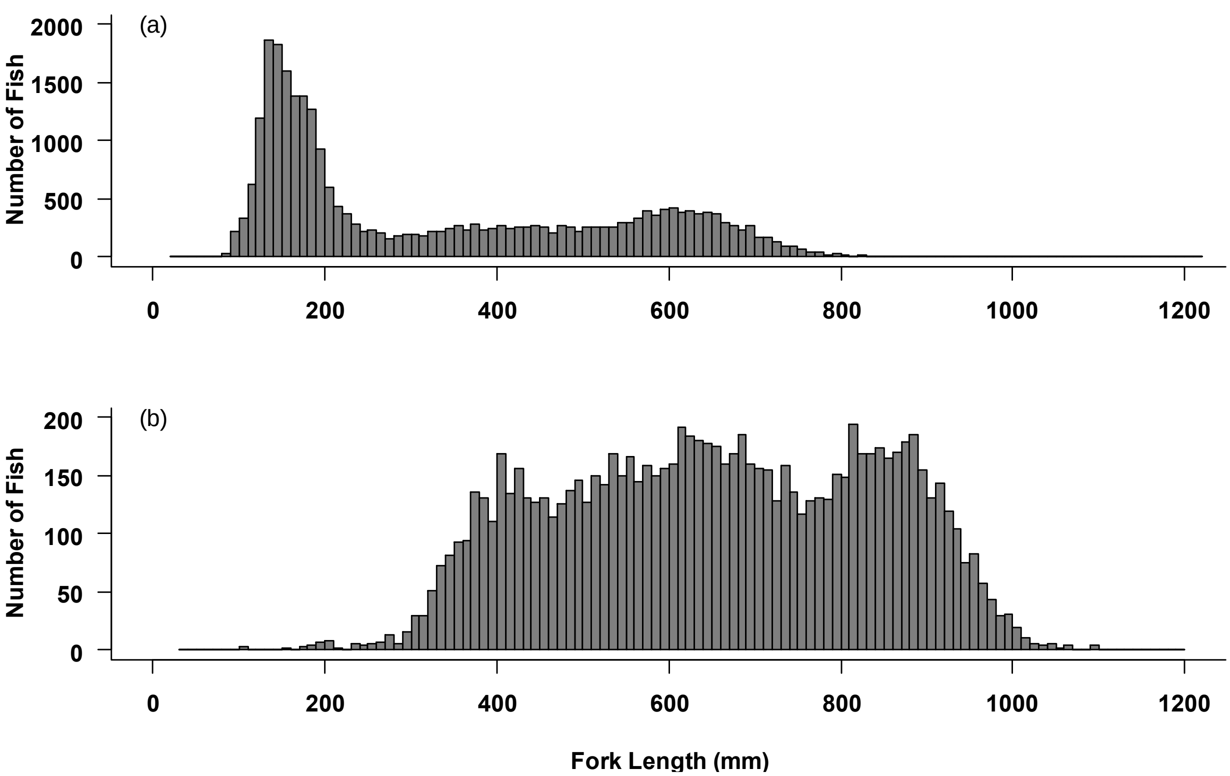


FIG. 7.1.3. Size distribution (fork length in mm) of Chinook Salmon caught (a) in the Fish Community Index Gill Netting Program from 1992 – 2016 (Section 1.1) and (b) by anglers in the Western Lake Ontario Angler Survey from 1995 to 2016

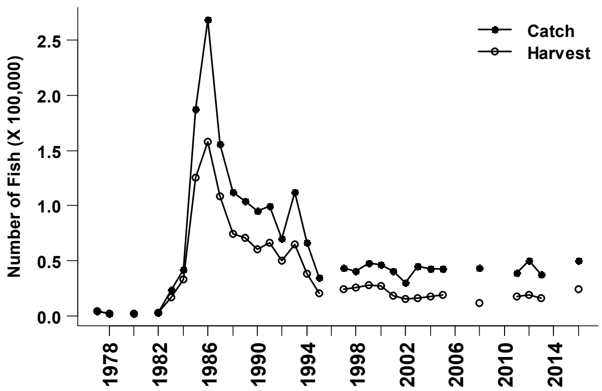


FIG. 7.1.5. Number of Chinook Salmon caught (shaded) and harvested (open) annually in the Ontario waters of Lake Ontario (excluding the Eastern Basin), 1977 to 2016. Dashed line represents the mean catch and harvest from 1997 to 2016.

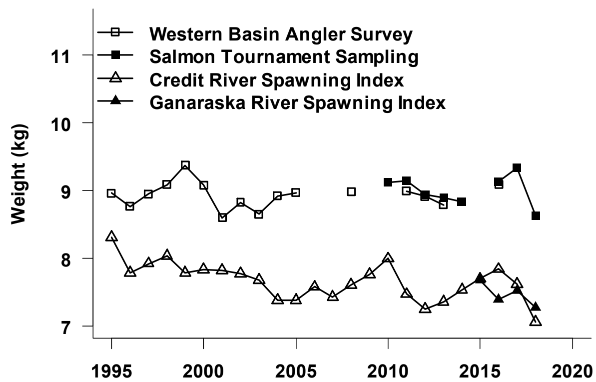


FIG. 7.1.6. Condition index of Chinook Salmon from Credit River Spawning Index (open triangle), Ganaraska River Spawning Index (shaded triangle), Western Basin Angling Survey (open square) and the Salmon Tournament Sampling (shaded square) from 1989 – 2018. Condition index is the predicted weight (based on a log-log regression) of a 914 mm (36") total length Chinook Salmon.

Catch per unit effort (CUE), total catch and total harvest is assessed by the Western Lake Ontario Boat Angler Survey. This program is on a three-year rotation schedule and was last conducted in 2016. In 2016, total effort increased slightly from 2013 (Fig. 7.1.4) and total catch and harvest were 8% and 9% above the mean through 1997 to 2016 (Fig. 7.1.5). Release rates in both the Western Lake Ontario Boat Fishery and the Lake Ontario Volunteer Angler Program have generally increased through time. In 2016, the release rates in the Western Lake Ontario Boat Fishery declined to 50% from the 2004 to 2016 average of 59%. Chinook Salmon release rates reported in the Lake Ontario Volunteer Angler Program were lower in 2016 (55%) compared to 2015 (68%) and 2014 (65%; see 2016 Lake Ontario Management Unit Annual Report).

The condition of Lake Ontario Chinook Salmon has been evaluated through four separate LOMU programs: i) Ganaraska River Trout and Salmon Assessment (Section 1.4), ii) Credit River Trout and Salmon Assessment (Section 1.5), iii) Chinook Salmon Tournament Sampling (Section 2.4) and iv) Western Lake Ontario Angler Survey. Chinook Salmon in the Credit River and Ganaraska River index have lower conditions relative to fish sampled in the lake during mid-summer when condition should be at a maximum. Overall, Chinook Salmon condition, evaluated using data from the Credit River Chinook Spawning Index (Section 1.5), has declined since 1989 (Fig. 7.1.6). In 2012, Credit River Chinook Salmon condition hit a low point in the time series. Since this time, condition in the Credit River increased to a peak 2016, followed by declines in 2017 and 2018. Credit River Chinook Salmon condition is at its lowest point in the time series (Fig 7.1.6). The condition of Chinook Salmon on the Ganaraska River has been measured over the past four years (2015 to 2018). On average, the condition of the Ganaraska River Chinook Salmon is lower than the Credit River (Fig. 7.1.6). Similar to the Credit River, condition of Ganaraska River Chinook Salmon declined in 2018 (Fig. 7.1.6). 2018 marked a sharp decline in condition of Chinook Salmon harvested during summer tournaments (Section 2.4). The condition of Chinook Salmon sampled in tournaments (Section 2.4) and the Western Basin Angler Survey have been comparable and follow similar trends. In 2018, each of our three programs monitoring Chinook Salmon exhibited estimated declines in condition (Fig. 7.1.6).

In 2018, LOMU operated the Riverwatcher fish counting system in the Ganaraska River Fishway from March 26th to November 22nd, 2018. In addition, a second Riverwatcher system was installed on the Credit River and became operational August 14th, 2018 and ran until November 15th, 2018. The first Chinook Salmon to migrate upstream through the Ganaraska Fishway was observed on July 23rd, 2018. Since this time, a total of 9,067 Chinook Salmon were identified migrating upstream through the Riverwatcher in the Ganaraska Fishway (Fig. 7.1.7; Section 1.4). In 2018 a total of 1,390 Chinook Salmon were observed passing through the Riverwatcher fish counter on the Streetsville Fishway during the monitoring period (August

14th to November 15th, 2018). On the Credit River, the first Chinook Salmon was observed August 20th, 2018 and the last on October 30th, 2018 (Fig. 7.1.8; Section 1.5). The Ganaraska and Credit River Trout and Salmon Assessment will continue in 2019 allowing for the development of new indices on this important species. These fish counting systems augment current Lake Ontario salmon and trout assessment, providing more information on spawning populations of migratory trout and salmon from early-spring to late-fall

In 2018, average fork length of Chinook Salmon at age-2 and age-3 decreased for both males and females (Section 1.5; Fig. 1.5.10). The average fork length of age-2 and age-3 male/ female Chinook Salmon is not below the long-term average. In 2018, female condition was lower than 2017; its first decline since 2015 (Section 1.5; Fig. 1.5.11). A sharp decline in male condition was observed in 2018 as well (Section 1.5; Fig. 1.5.11). Female condition in 2018 is the lowest in the 29-year time series; male condition in 2018 is below the previous 10-year average.

Body condition of Chinook Salmon collected on the Credit River and Ganaraska River during the egg collection was comparable in 2018 (Fig. 7.1.6). Monitoring and assessment of both Credit River and Ganaraska River salmon and trout provides comparisons between fish populations that are predominantly of stocked origin (Credit River) and completely naturalized (Ganaraska River). Continued monitoring and assessment of these populations on the Credit and Ganaraska Rivers is critical in understanding the dynamic between stocked and naturalized fish populations as well as the success of the Lake Ontario Management Unit's diverse egg collection strategy with Chinook Salmon.

Mean summer temperatures for Lake Ontario were above the long-term average in 2018 (Section 11.1); a sharp contrast to the 2014 and 2015 seasons, which marked the coldest mean summer water temperatures recorded since 2002 (Section 11.1). In addition, the winter of 2017-2018 was severe compared to the previous years (Section 11.1). While, these two factors may not be the only ones behind the observed declines in Chinook Salmon size, they likely have a significant contribution, as cooler temperatures are associated with lower metabolic activity and growth and severe winters negatively affect prey fish populations (i.e., Alewife).

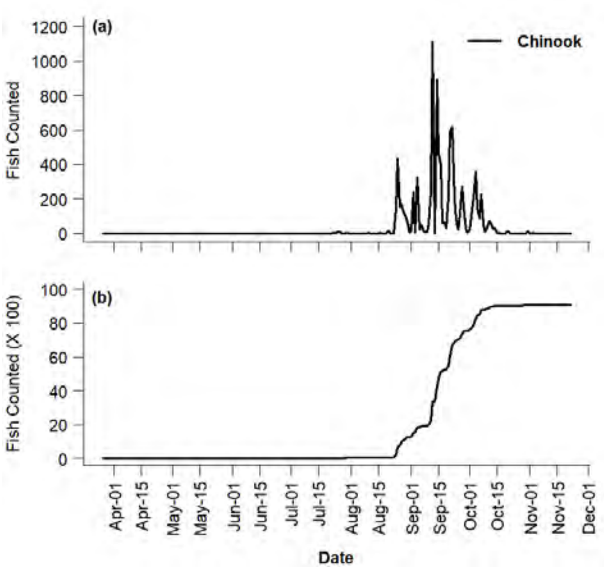


FIG. 7.1.7. (a) Daily and (b) cumulative observed counts of Chinook Salmon at the Ganaraska River fishway at Port Hope, Ontario from March 26th to November 22nd, 2018.

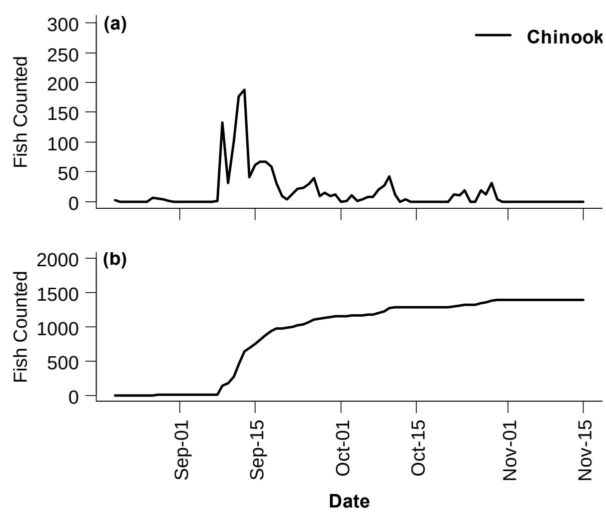


FIG. 7.1.8. (a) Daily and (b) cumulative observed counts of Chinook Salmon at the Streetsville Fishway, Credit River, Mississauga, Ontario from August 14th to November 15th, 2018.

7.2 Rainbow Trout

M. J. Yuille, Lake Ontario Management Unit

The Lake Ontario fish community is a mix of non-native and remaining native species. Rainbow Trout, a non-native species, was intentionally introduced to Lake Ontario in 1968 and has since become naturalized (naturally reproducing fish). Rainbow Trout are the primary target for tributary anglers, who take advantage of the seasonal staging and spawning runs of this species. Rainbow Trout are the second most sought-after species in the Ontario waters of the Lake Ontario offshore salmon and trout fishery. In addition, the spring and fall spawning runs attract high numbers of tourists to local tributaries to watch these fish jump at fishways and barriers along their spawning migration. For all of these reasons, Rainbow Trout are not only ecologically important but recreationally and economically important as well.

The OMNRF stocks only *Ganaraska River* strain Rainbow Trout into Lake Ontario. A total of 183,100 Rainbow Trout were stocked, slightly above the 2009 to 2018 average of 166,390 (Fig. 7.2.1; see Section 6.1).

The spring spawning run of Rainbow Trout in the Ganaraska River has been estimated at the fishway at Port Hope since 1974 (Section 1.1). In 2018, the Lake Ontario Management Unit (LOMU) operated the new Riverwatcher fish counting system in the Ganaraska River Fishway from March 26th to November 22nd, 2018. In 2018, the spring Rainbow Trout run in the Ganaraska River increased from 6,952 fish in 2017 to 9,014 fish and is now above the previous 10-year average (7,823 fish from 2009 – 2018; Fig. 7.2.2). Additionally, Rainbow Trout were observed utilising the fishway after the spring monitoring period. From March 26th to November 22nd, 2018 a total of 9,194 Rainbow Trout were identified migrating upstream through the Ganaraska Fishway (Fig. 7.2.3).

The Lake Ontario ecosystem has changed dramatically during this time series (e.g., phosphorus abatement, dreissenid mussel invasion, round goby invasion). During this time period (1974 to 2018), Rainbow Trout condition has declined (Fig. 7.2.4a). With the exceptions of 1994 and 1996, the highest condition values occurred in the 1970's, prior to invasion of Zebra Mussels, Quagga Mussels and Round Goby. Fish body condition declined through the 1980's to a low point in 1987. From 1990 to 2018, the long-term trend shows slight decline in relative condition. Data on Rainbow Trout condition over the past 10 years are the most informative for the current population (Fig. 7.2.4b). Rainbow Trout

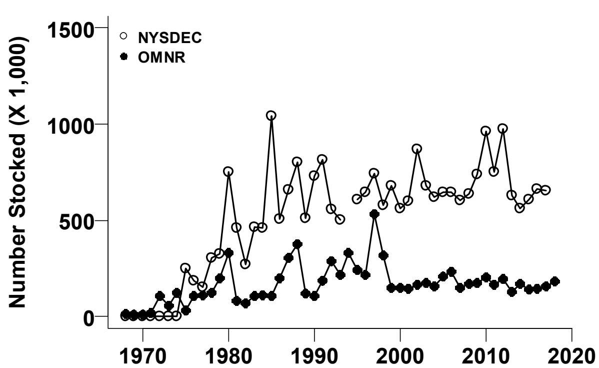


FIG. 7.2.1: Number of Rainbow Trout stocked by New York State Department of Environmental Conservation (NYSDEC) and OMNRF from 1968 – 2018 (see Section 6.1).

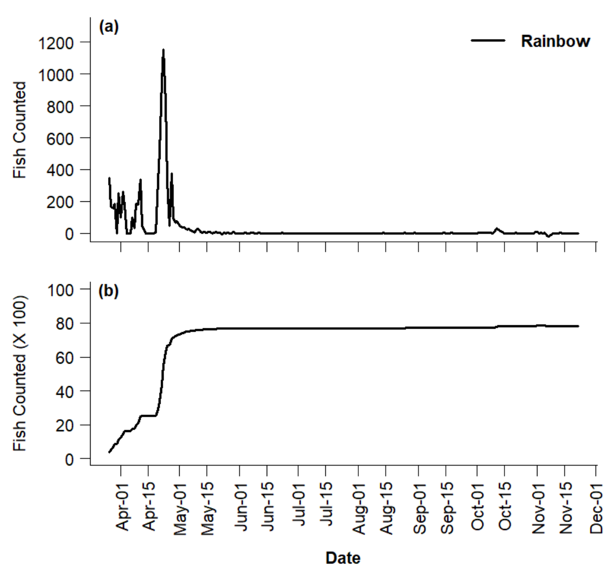


FIG. 7.2.3. (a) Daily and (b) cumulative observed counts of Rainbow Trout at the Ganaraska River fishway at Port Hope, Ontario from March 26th to November 22nd, 2018.

condition declined to a low in 2008 then has increased up to 2013 (the highest in the whole time series since 1997). In 2015, Rainbow Trout condition declined significantly, to the lowest point since 1986. Since 2015 Rainbow Trout condition has remained stable (94-96%) but below the previous 10 year average relative condition value (97% from 2009 to 2018; Fig. 7.2.4b).

After a sharp increase in catch per unit effort (CUE) from 1979 to 1984 (the highest in the 34 year time series), the CUE declined until 2004 in the Western Lake Ontario Boat Fishery (Fig. 7.2.5). After 2004 (the lowest CUE since 1982), the CUE steadily increased to 2013. The Lake Ontario Management Unit, did not evaluate the Western Lake Ontario Boat Fishery in 2014 or 2015, but Rainbow Trout CUE in 2016 showed a significant decline, falling below the average CUE for both the time series (1977-2016) and the past 10 years (2008 to 2016; Fig. 7.2.5). Effort in this fishery has remained fairly stable since 1994 (Fig. 7.2.5). Total numbers of Rainbow Trout caught and harvested in the Western Lake Ontario Boat Fishery naturally followed the same trends found in CUE with total harvest generally lower than total catch (Fig. 7.2.6).

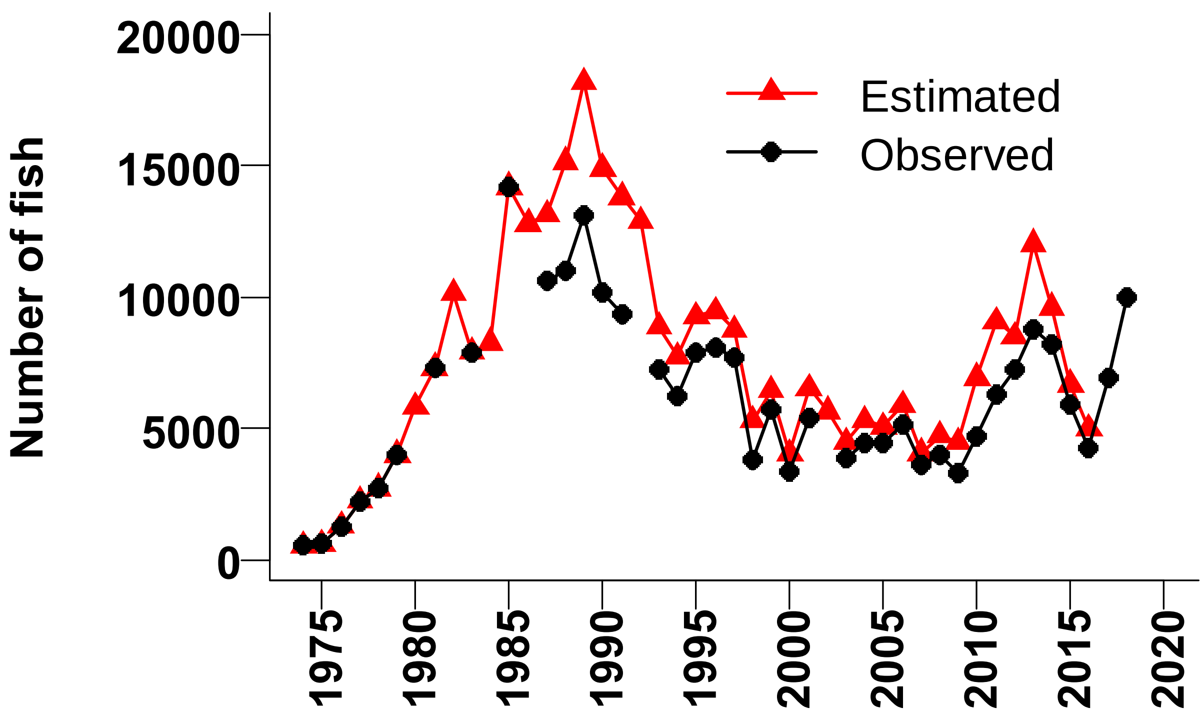


FIG. 7.2.2. Estimated and observed spring run of Rainbow Trout at the Ganaraska River fishway at Port Hope, Ontario from 1974 – 2018.

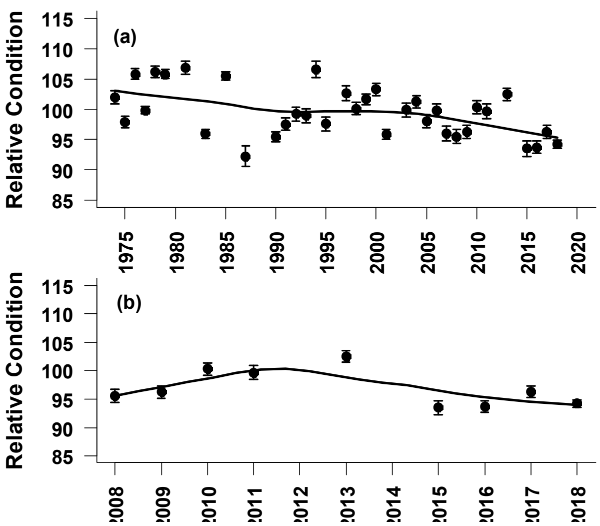


FIG. 7.2.4. Relative condition of Rainbow Trout sampled at the Ganaraska River fishway at Port Hope, Ontario for (a) the whole time series 1974 – 2018 and (b) from 2008 – 2018; see Section 1.4).

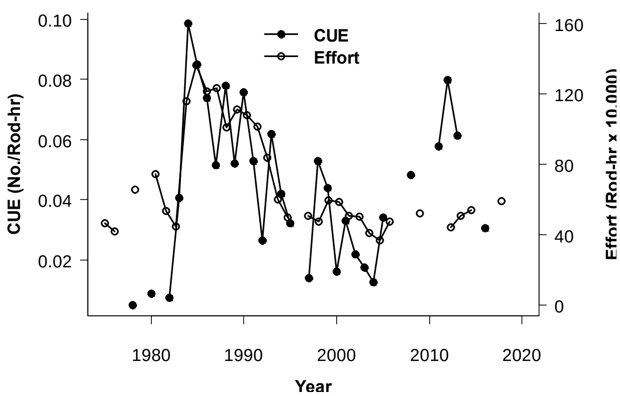


FIG. 7.2.5. Catch rate (CUE) of Rainbow Trout and total effort (rod-hrs) in the Ontario waters of Lake Ontario (excluding Kingston Basin), 1977 – 2016.

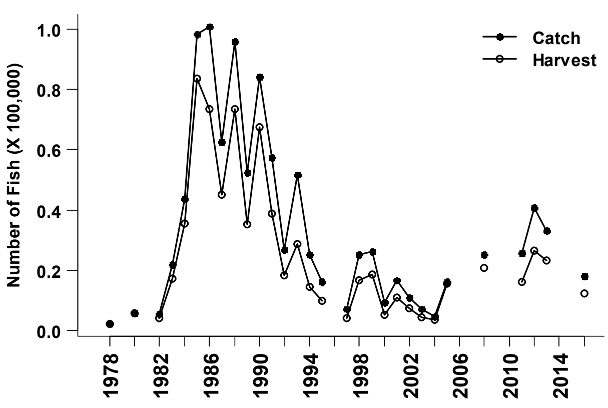


FIG. 7.2.6. Number of Rainbow Trout caught (closed circle) and harvested (open circle) annually by the boat fishery in the Ontario waters of Lake Ontario (excluding Kingston Basin), 1978 – 2016. The dashed line represents the mean catch and harvest from 2000 to 2016.

7.3 Brown Trout

M. J. Yuille and J. A. Hoyle, Lake Ontario Management Unit

Brown Trout, in conjunction with several other stocked and naturalized trout and salmon species support a Lake Ontario main basin recreational fishery. Salmon and trout returning to rivers to spawn also support important shore and tributary fisheries. Ontario's Brown Trout stocking levels have increased slightly from 2000 to 2018, while New York stocking rates have remained stable (Fig. 7.3.1). Stocking numbers in 2018 increased to the highest level since the early 1990s (Fig. 7.3.1; Section 6.1). The 2018 average catch per standard net (0.23 fish per net) in the Community Index Gill Netting showed a sharp increase from the previous four years and was comparable to the previous 10-year average (0.21 fish per net Fig. 7.3.2). Brown Trout that were caught during Fish Community Index Gill Netting were biologically sampled, recording length and weight information as well as age structures for age interpretation (Section 1.1). Ontario stocks Brown Trout as yearlings and they can reach a maximum age of five. In 2018, most of the Brown Trout caught in Fish Community Index Netting were age-2 (81%) followed by age-3 (13%; Table 7.3.1)

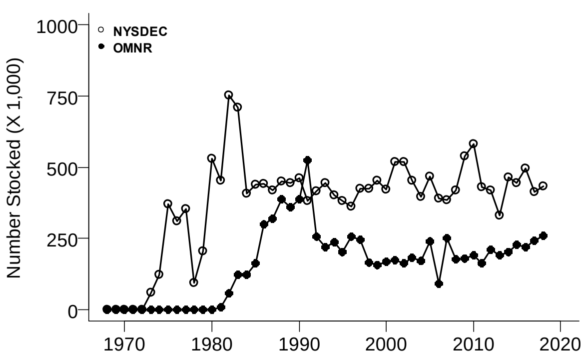


FIG. 7.3.1 Number of Brown Trout stocked by New York State Department of Environmental Conservation (NYSDEC) and OMNRF from 1968 – 2018 (see Section 6.1).

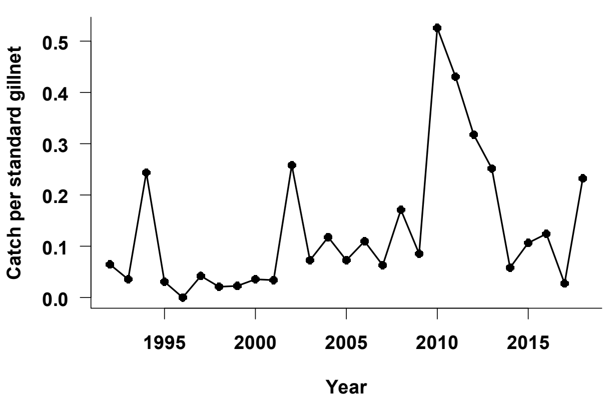


FIG. 7.3.2. Number of Brown Trout caught per gill net (CUE) from the Fish Community Index Gill Netting Program (see Section 1.1) from 1992 – 2018.

Based on stakeholder and public consultation, Ontario's stocking strategy for Lake Ontario Brown Trout changed in 2015 to include: increased size of stocked Brown Trout and the stocking of fewer locations with more fish to increase fish density and angler success, creating high quality destination fisheries for Brown Trout. In 2018, the Lake Ontario Management Unit expanded their Fish Community Index Gill Netting Program (Section 1.1) to include two areas that sampled in the vicinity of the aforementioned Brown Trout stocking locations (Athol Bay and Port Dalhousie). Preliminary results have shown no statistical differences in the number of Brown Trout caught at stocking locations (Port Dalhousie and Athol Bay) and non -stocking locations (Port Credit, Cobourg, Brighton, Wellington and Rocky Point; Fig. 7.3.3). When comparing area specific catches of Brown Trout, catches at Port Dalhousie were significantly higher than catches at Port Credit, but there were no other statistically significant differences between all other site comparisons (Fig 7.3.3). Some catches may have been affected by weather and lake currents (e.g., Athol Bay). Analyses and interpretation of the 2018 data are ongoing to fully understand the effects of the changes to the Brown Trout stocking strategy.

TABLE 7.3.1. Age distribution of 86 Brown Trout sampled from Fish Community Index Gill Nets, by region, during 2018 (Section 1.1). Also shown are mean fork length (mm) and mean weight (g).

	Age (years)/year-class				
	1	2	3	4	
Region	2017	2016	2015	2014	Total
Western		17	6		23
Central	1	5	2	1	9
Northeast	3	40	3		46
Kingston Basin (nearshore)		4			4
Kingston Basin (deep)		3			3
Bay of Quinte		1			1
Total aged	4	70	11	1	86
Mean fork length (mm)	441	513	546	705	
Mean weight (g)	1431	2287	2885	5398	

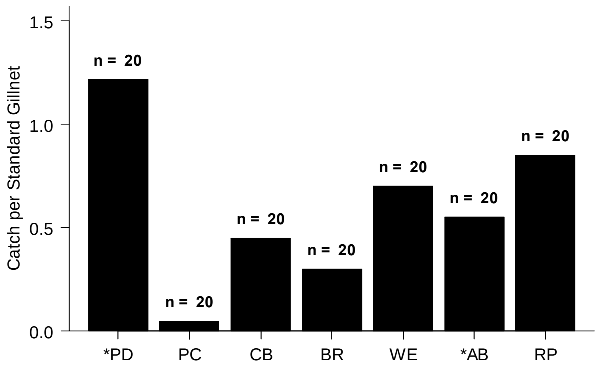


FIG. 7.3.3. Number of Brown Trout caught per gill net (CUE) from specific areas fished during the 2018 Fish Community Index Gill Netting Program to evaluate the effects of the new Brown Trout stocking strategy. Areas include: Port Dalhouise (PD), Port Credit (PC), Cobourg (CB), Brighton (BR), Wellington (WE), Athol Bay (AB) and Rocky Point (Section 1.1). N is the total number of nets set. Areas marked with "*" indicate Brown Trout stocking locations (see Section 6.1).

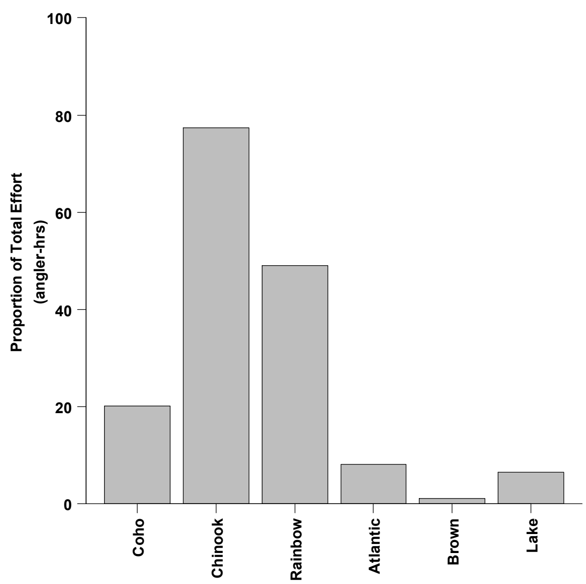


FIG. 7.3.4. The proportion of targeted angling effort (angler hours) for specific salmon and trout species relative to the total estimated targeted angling effort in 2016.

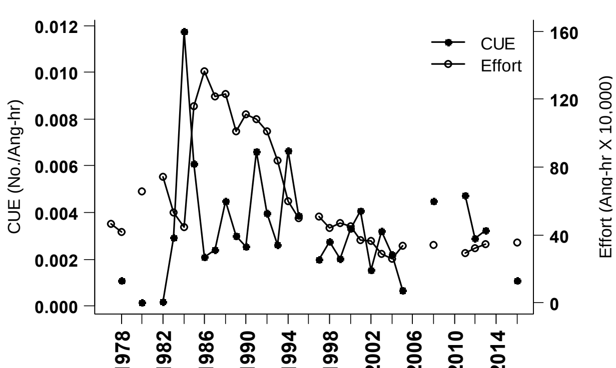


FIG. 7.3.5. Catch rate (CUE) of Brown Trout and annual total effort (ang-hrs) in the Ontario waters of Lake Ontario (excluding the Eastern Basin), 1977 to 2016.

Brown Trout are the least targeted salmon and trout species in the Lake Ontario open-water fishery (Fig. 7.3.4). Catch per angler hour of Brown Trout in the recreational fishery (0.001 fish per ang-hr in 2016) has been low but stable since the early 2000s (0.003 fish per ang-hr; Fig. 7.3.5). Catch and harvest in the most recent Lake Ontario salmon and trout recreational angler survey (2016 Lake Ontario Management Unit Annual Report) was the lowest since the mid-2000s (Fig. 7.3.6). Unlike other salmon and trout species (e.g., Chinook Salmon, Section 7.1) length distributions of Brown Trout harvested in the Lake Ontario recreational fishery and caught in Fish Community Index Gill Netting (Fig. 7.3.7) were similar.

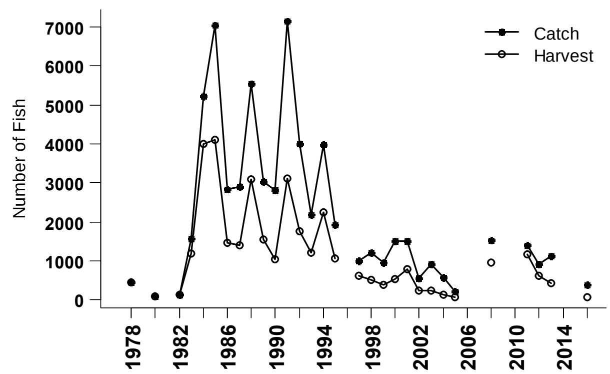


FIG. 7.3.6. Number of Brown Trout caught (closed circle) and harvested (open circle) annually in the Ontario waters of Lake Ontario (excluding the Eastern Basin), 1977 to 2016.

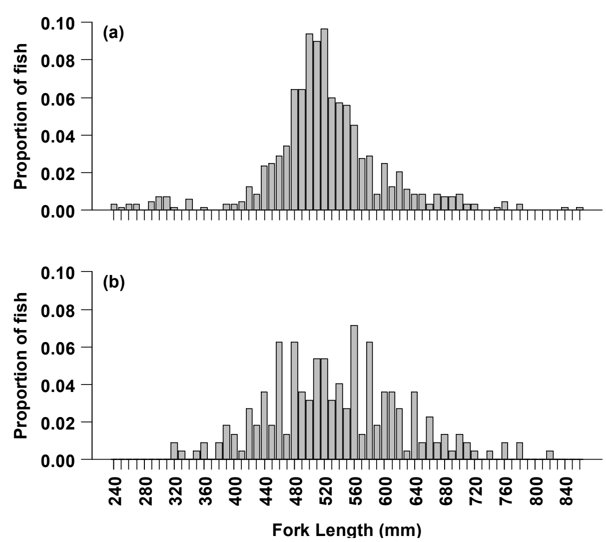


FIG. 7.3.7. Size distribution (fork length in mm) of Brown Trout caught (a) in the Fish Community Index Gill Netting Program from 1992 – 2018 (Section 1.1) and (b) by anglers in the Western Lake Ontario Angler Survey from 1995 to 2016.

The condition of Lake Ontario Brown Trout has been evaluated through two separate LOMU programs: i) Fish Community Index Gill Netting (Section 1.1) and ii) the Western Lake Ontario Angler Survey. Body condition is represented by relative condition of Brown Trout smaller than 625 mm fork length ("Small") and greater than or equal to 625 mm fork length ("Large"). The fish were grouped into these two size classes to reduce bias associated with non-linear growth. Relative condition of small Brown Trout caught in Fish Community Index Netting increased from a low point in 1998 to one of the highest in 2002 (Fig. 7.3.8a). This coincides with the invasion of Round Goby into Lake Ontario. Brown Trout are known to eat Round Goby to supplement their diets; the increase in Brown Trout body condition observed may be due to the incorporation of Round Goby in their diet. Body condition of large Brown Trout has been variable but stable throughout the time series (Fig. 7.3.8b). Relative condition measured in the Western Basin Angler Survey is generally lower than that of the Fish Community Index Gill Netting, but follows the same trends (Fig. 7.3.8). In the Western Basin Angler Survey, Brown Trout are primarily targeted and caught early in the season (April and May). As a result, we would expect that their condition would be lower relative to Fish Community Index Gill Netting (July and August) as they have not had the same amount of time to recover from the winter and grow throughout the summer.

The Lake Ontario Management Unit installed and operated two Riverwatcher fish counters in the Ganaraska River (March 26th to November 22nd, 2018) and the Credit River (August 14th to November 15th, 2018). In 2018, 183 Brown Trout were identified passing through the Ganaraska Fishway (Fig. 7.3.9, Section 1.4). In both 2017 and 2018, Brown Trout were the most active salmon and trout species utilising the fishway from June to early August (Fig. 7.3.9). On the Credit River, a total of five Brown Trout were identified passing through the fish counter during the monitoring period (Fig. 7.3.10, Section 1.5).

In 2019, the Riverwatcher fish counters will be installed on both the Credit and Ganaraska Rivers and monitored during the ice-free season. This will provide a more robust assessment of Brown Trout activity on the Credit River. These fish counting systems augment current Lake Ontario salmon and trout assessment, providing more information on spawning populations of migratory trout and salmon from early-spring to late-fall.

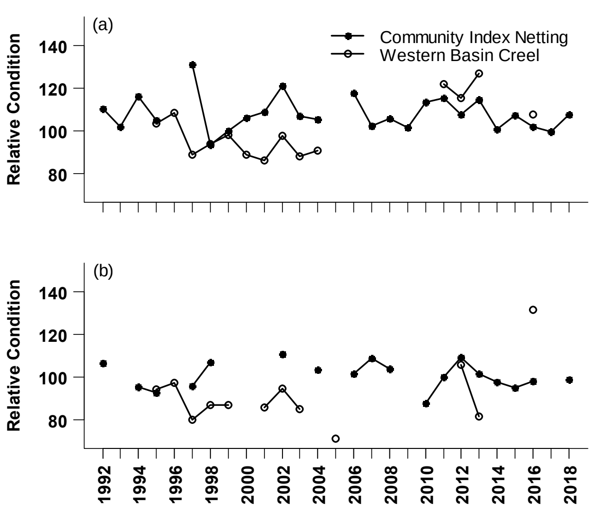


FIG. 7.3.8. Relative condition of (a) small and (b) large Brown Trout from Fish Community Index Gill Netting (closed circle) and Western Basin Angling Survey (open circle) 1992 – 2018. The data point for small Brown Trout in 2005 Western Basin Creel was removed as an outlier.

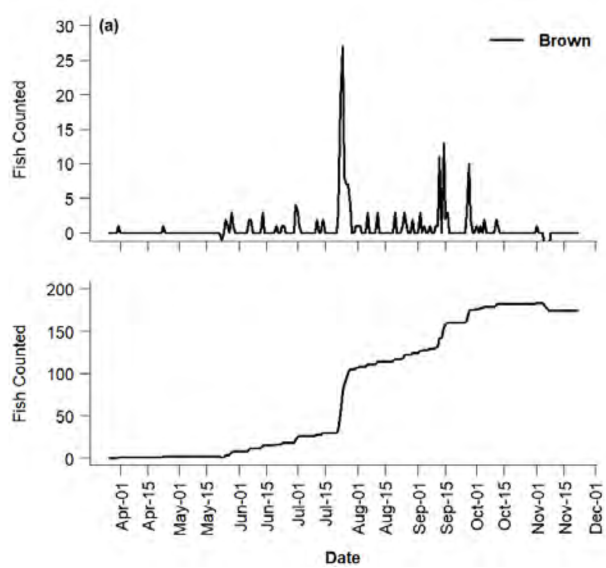


FIG 7.3.9. (a) Daily and (b) cumulative observed counts of Brown Trout at the Ganaraska River fishway at Port Hope, Ontario from March 26th to November 22nd, 2018 .

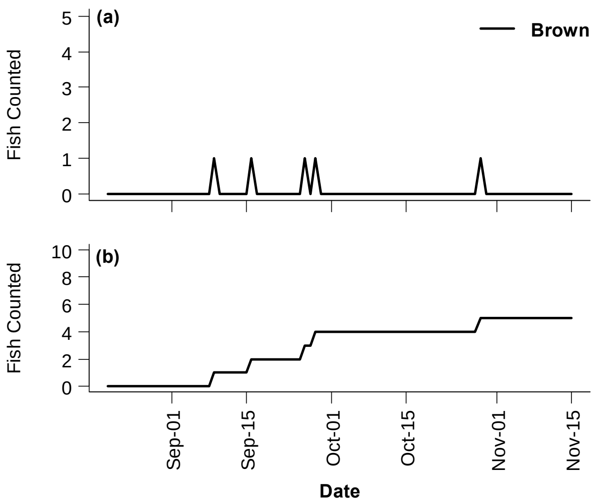


FIG. 7.3.10. (a) Daily and (b) cumulative observed counts of Brown Trout at the Streetsville Fishway, Credit River, Mississauga, Ontario from August 14th to November 15th, 2018.

7.4 Lake Whitefish

J. A. Hoyle and E. Brown, Lake Ontario Management Unit

Lake Whitefish is a prominent member of the eastern Lake Ontario cold-water fish community and an important component of the local commercial fishery. Two major spawning stocks are recognized in Canadian waters: one spawning in the Bay of Quinte and the other in Lake Ontario proper along the south shore of Prince Edward County. A third spawning area is Chaumont Bay in New York State waters of eastern Lake Ontario.

Commercial Fishery

Lake Whitefish commercial quota and harvest increased from the mid-1980s through the mid-1990s, declined through to the mid-2000s then stabilized at a relatively low level (Fig. 7.4.1). Quota and harvest averaged 123,000 lb and 77,000 lb respectively, over the 2009-2018 time-period. In 2018, base quota was 134,879 lb, issued quota was 128,940 lb and the harvest was 56,156 lb (Section 3.2). In recent years, most of the harvest occurs in quota zone 1-2, eastern Lake Ontario (Fig. 7.4.2). Here, fishing effort, harvest and harvest rate (HUE) declined from the mid-1990s until the mid-2000s and then generally leveled off (Fig. 7.4.3).

The age distribution of Lake Whitefish harvested is comprised of many age-classes (Fig. 7.4.4). Most fish are age-5 to age-14.

Abundance

Lake Whitefish abundance is assessed in a number of LOMU programs. Summer Fish Community Index Gill Netting is used to assess relative abundance of juvenile and adult fish in eastern Lake Ontario (Fig. 7.4.5, and see Section 1.1). Young-of-the-year (YOY) abundance is assessed in bottom trawls (Section 1.2) at Conway (lower Bay of Quinte) and Timber Island (EB03 in eastern Lake Ontario) (Fig. 7.4.5). Lake Whitefish abundance, like commercial harvest, has been stable at a relatively low level for the last decade. YOY catches have been highly variable.

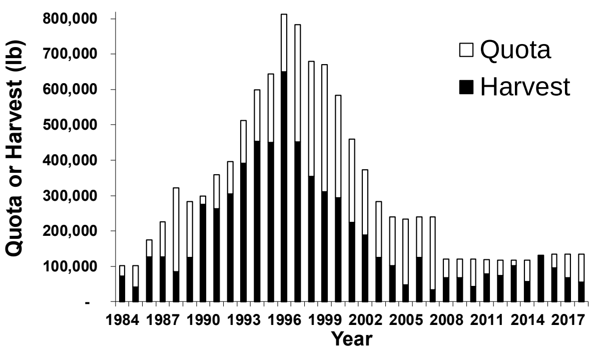


FIG. 7.4.1. Lake Whitefish commercial quota and harvest, 1984-2018.

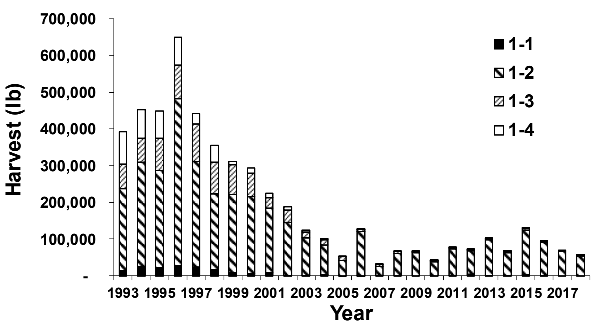


FIG. 7.4.2. Lake Whitefish commercial harvest by quota zone, 1993-2018.

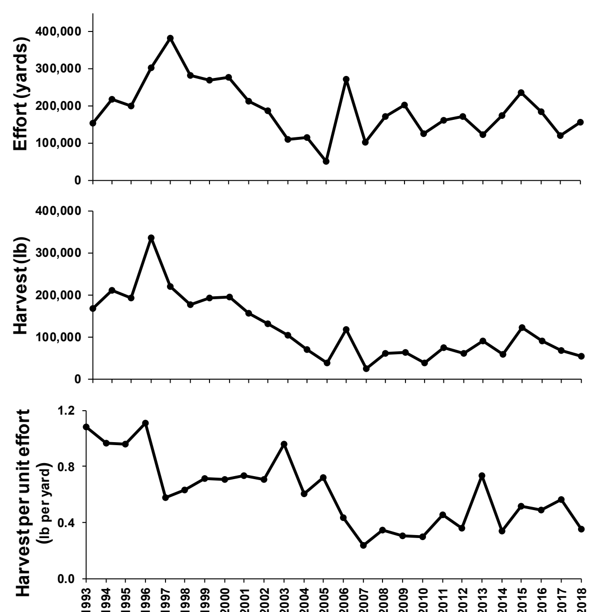


FIG. 7.4.3. Commercial Lake Whitefish gill net fishing effort (top panel), harvest (middle panel), and harvest-per-unit-effort (HUE; bottom panel) in quota zone 1-2, 1993-2018.

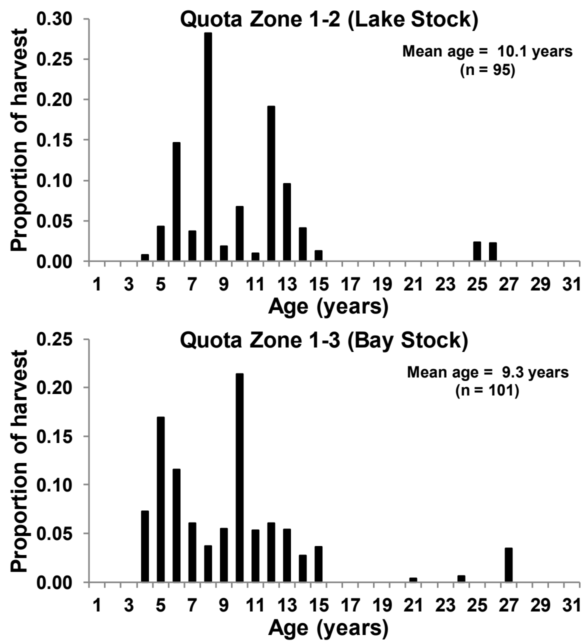


FIG. 7.4.4. Lake Whitefish age distributions (by number) in the 2018 quota zones 1-2 (upper panel) and 1-3 (lower panel) fall commercial fisheries.

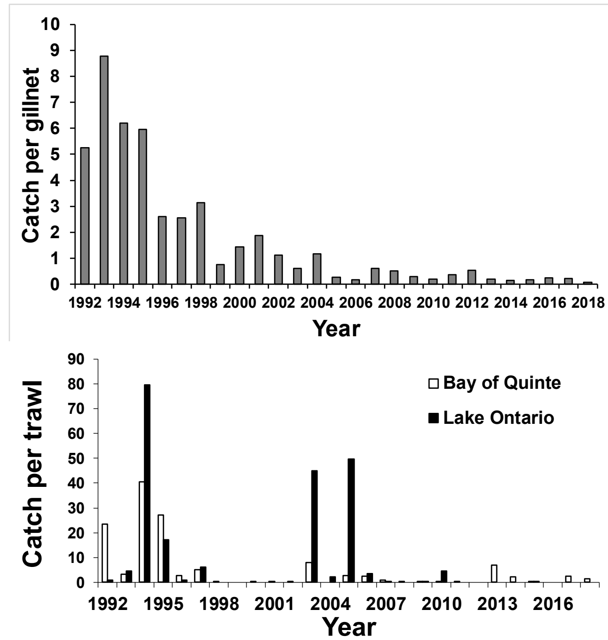


FIG. 7.4.5. Lake Whitefish abundance in eastern Lake Ontario assessment gill nets, 1992-2018 (sub-adult and adult; upper panel) and bottom trawls, 1992-2018 (young-of-the-year; lower panel).

Condition

Trends in Lake Whitefish condition during summer and fall are shown in Fig. 7.4.6. Condition was high from 1990-1994, and declined through 1996. Condition then increased to intermediate levels for Lake Whitefish sampled during summer but condition remained low for fish sampled during fall.

Overall Status

Following severe declines in abundance, commercial harvest, growth and condition, during the 1990s, the eastern Lake Ontario Lake Whitefish population appears to have stabilized at a much reduced but stable level of abundance, and condition.

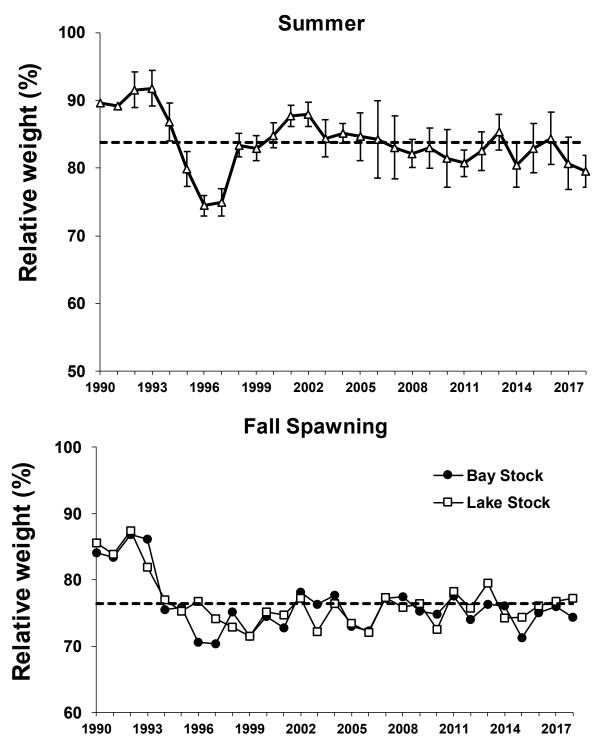


FIG. 7.4.6. Condition (relative weight) of Lake Whitefish sampled during summer assessment gill net surveys in eastern Lake Ontario (upper panel error bars ±2SE) and fall commercial catch sampling (lower panel) in the Bay of Quinte ("Bay Stock") and the south shore Prince Edward County ("Lake Stock"), 1990-2018.

7.5 Walleye

J. A. Hoyle and E. Brown, Lake Ontario Management Unit

Walleye is the Bay of Quinte fish community's primary top piscivore and of major interest to both commercial (Section 3.2) and recreational fisheries (Section 2.3). The Walleye population in the Bay of Quinte and eastern Lake Ontario is managed as a single large stock. The Walleye's life history-specific movement and migration patterns between the bay and the lake determines the seasonal distribution patterns of the fisheries. Understanding Walleye distribution is also crucial to interpret summer assessment netting results (Sections 1.1 and 1.2). After spawning in April, mature Walleye migrate from the Bay of Quinte toward eastern Lake Ontario to spend the summer months. These mature fish return back "up" the bay in the fall to over-winter. Immature Walleye generally remain in the bay year-round. In 2017 a multi-year acoustic telemetry project was initiated to describe Bay of Quinte-eastern Lake Ontario Walleye movement at a finer scale than currently exists (Section 9.16 and 9.17).

Recreational Fishery

The recreational fishery consists of a winter ice-fishery and a three season (spring/summer/fall) open-water fishery. Most Walleye harvest by the recreational fishery occurs in the upper and middle reaches of the Bay of Quinte during the winter ice-fishery (Fig. 7.5.1) and the spring/early summer open-water fishery. All sizes of fish are caught during winter while mostly juvenile fish (age-2 and age-3) are caught during spring and summer. A popular "trophy" Walleye fishery occurs each fall based on the large, migrating fish in the middle and lower reaches of the Bay of Quinte at that time (see Section 2.3). Increasingly in recent years, there is also a late-summer fishery in eastern Ontario targeted at these large Walleye prior to their return to the Bay of Quinte. Trends in the open-water fishery are shown in Fig. 7.5.2. Annual Walleye angling effort and catch (ice and open-water fisheries combined) has been relatively stable averaging over 330,000 hours and 63,000 fish caught during the last decade. Walleye catch and harvest spiked in the 2017 open-water fishery (102,351 and 52,651 fish, respectively) as two very strong year-classes (age-2 and 3) recruited to the fishery.

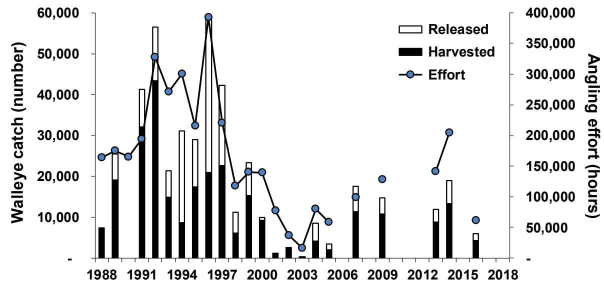


FIG. 7.5.1. Bay of Quinte recreational angling effort and walleye catch (released and harvested) during the winter ice-fishery, 1988-2017. No data for 2006, 2008, 2010-2012, 2015, 2017 or 2018.

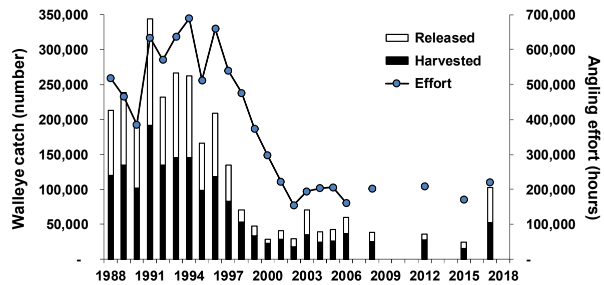


FIG. 7.5.2. Bay of Quinte recreational angling effort and walleye catch (released and harvested) during the open-water fishery, 1988-2017. No data for 2007, 2009-2011, 2013-2014, 2016 or 2018.

Commercial Fishery

Walleye harvest by the commercial fishery is highly regulated and restricted. No commercial Walleye harvest is permitted in the upper and middle reaches of the bay (Trenton to Glenora). A relatively modest Walleye commercial quota (48,093 lbs; Fig. 7.5.3) is allocated in the lower Bay of Quinte and Lake Ontario with additional seasonal, gear, and fish-size restrictions. The commercial harvest of Walleye was 26,201 lbs in 2018 (see Section 3.2). Commercial Walleye harvest has shifted location from quota zone 1-2 to 1-4 over the last decade (Fig. 7.5.4). This shift has likely resulted in smaller, younger Walleye being harvested but this has not been measured.

Annual Harvest

Total annual Walleye harvest in the recreational and commercial fisheries (by number and weight) over the last decade (2009-2018) is given in Table 7.5.1. The recreational fishery takes about 80% of the annual harvest with the open-water component of the recreational fishery

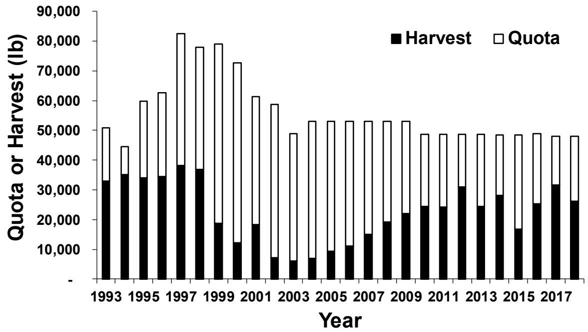


FIG. 7.5.3. Walleye commercial quota and harvest, 1993-2018.

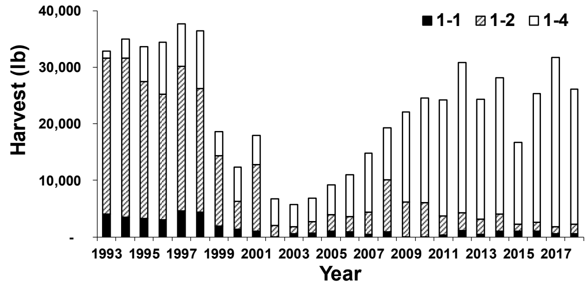


FIG. 7.5.4. Walleye commercial harvest by quota zone, 1993-2018.

making up 62% (by number) of total annual harvest.

Abundance

Walleye abundance is assessed in a number of programs. Summer gill net sampling (Section 1.1) is used to assess relative abundance of juvenile (Bay of Quinte) and adult (eastern Lake Ontario) fish (Fig. 7.5.5). Fig. 7.5.6 shows the 2018 Walleye age distribution in these two geographic areas. Young-of-the-year (YOY) abundance is assessed in Bay of Quinte bottom trawls (Fig. 7.5.7; Section 1.2).

Except for an unusually high catch in 2013, juvenile abundance in the Bay of Quinte has been very stable since 2001 (Fig. 7.5.5). The 2018 catch was average with a large contribution of age -3 and 4 fish. In eastern Lake Ontario index gill nets, after an unusually low catch in 2013, Walleye abundance in eastern Lake Ontario increased to a level similar to that observed in the previous few years. The 2018 catch was high (Fig. 7.5.5). The 2014 catch of YOY Walleye in bottom trawls was the highest since 1994 (Fig. 7.5.7) and the 2015 year-class was also very large. The 2016 year-class was of moderate strength, and the 2017 year-class was poor. The 2018 year-class was good. These recent year-classes foreshadow continued stability in the Walleye population and fisheries.

TABLE 7.5.1. Mean annual Walleye harvest by major fishery over the last decade (2009-2018).

	Walleye harvest			
	Number of fish	lbs	% by number	% by weight
Recreational				
ice-fishery	9,245	29,724	18%	26%
open-water fishery	31,857	60,869	62%	52%
Commercial	10,178	25,446	20%	22%
Total	51,280	116,039	100%	100%

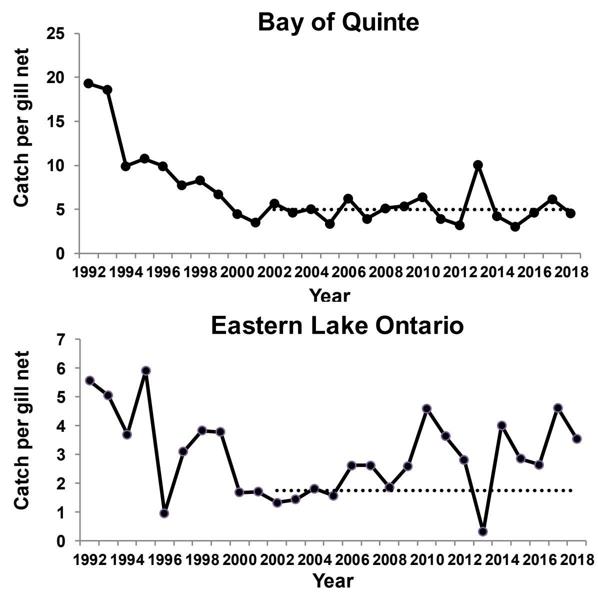


FIG. 7.5.5. Walleye abundance in summer gill nets in the Bay of Quinte, 1992-2018 (upper panel) and eastern Lake Ontario, 1992-2018 (lower panel). Also shown (dotted line) is the Bay of Quinte FMP (Fisheries Management Plan) "target" for these two components of the Walleye population.

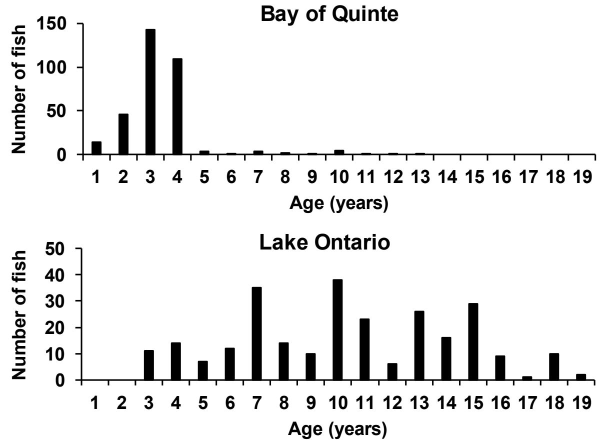


FIG. 7.5.6. Walleye age distribution in 2018 summer gill nets in the Bay of Quinte (upper panel) and Lake Ontario (lower panel).

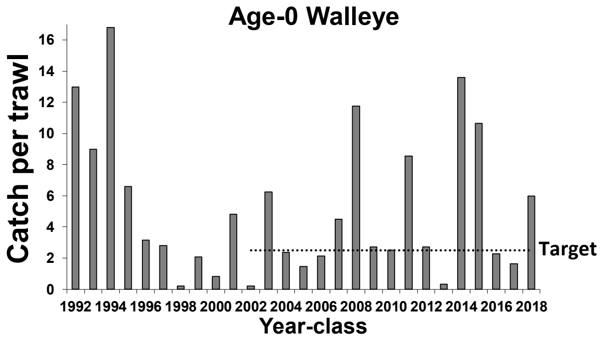


FIG. 7.5.7. Young-of-the-year (Age-0) Walleye catch per trawl in the Bay of Quinte, 1992-2018. Also shown (dotted line) is the Bay of Quinte FMP (Fisheries Management Plan) “target” catch per trawl.

Growth

Walleye length-at-age for age-2 and age-3 juvenile fish and age-10 mature fish (males and females separated) is shown in Fig. 7.5.8. Length -at-age increased for juvenile (age-2 and 3) fish in 2000 and remained stable since. For mature fish (age-10), length-at-age has remained stable with females being larger than males.

Condition

Walleye condition (relative weight) is shown in Fig. 7.5.9. Condition has remained stable in Bay of Quinte fish (immature) and showed an increasing trend in Lake Ontario (mature fish) until 2014 when condition declined sharply; condition in the lake increased in 2015 and 2016, held steady in 2017, and declined in 2018.

Other Walleye Populations

The Bay of Quinte / eastern Lake Ontario Walleye population is the largest on Lake Ontario; smaller populations exist in other nearshore areas of the Lake Ontario. Walleye in these other areas are regularly assessed with a standard trap net program (Nearshore Community Index Netting; see Section 1.3). Mean Walleye trap net catches (2008-2013 compared to 2014-2018 time-periods) in 12 geographic nearshore areas are shown in Fig. 7.5.10. Highest Walleye abundance occurs in the Bay of Quinte, East Lake, West Lake, Weller’s Bay and Hamilton Harbour. Walleye abundance increased in Hamilton Harbour after stocking efforts began in 2012 (see Section 8.6). Index gill netting on Lake St. Francis (St. Lawrence River) in 2018 showed increased Walleye abundance compared to 2016 (See Section 1.9).

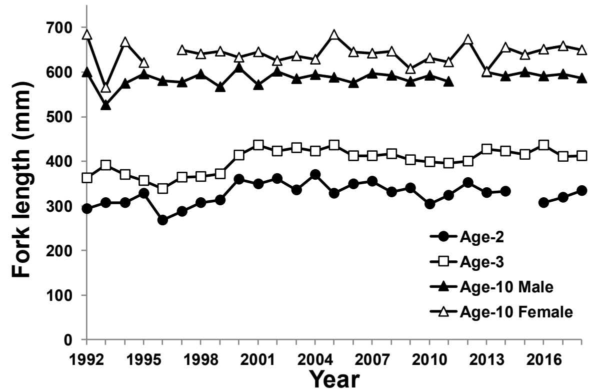


FIG. 7.5.8. Trends in Walleye fork length-at-age for age-2, age-3, age-10 males and females, caught in summer assessment gill nets, 1992-2018.

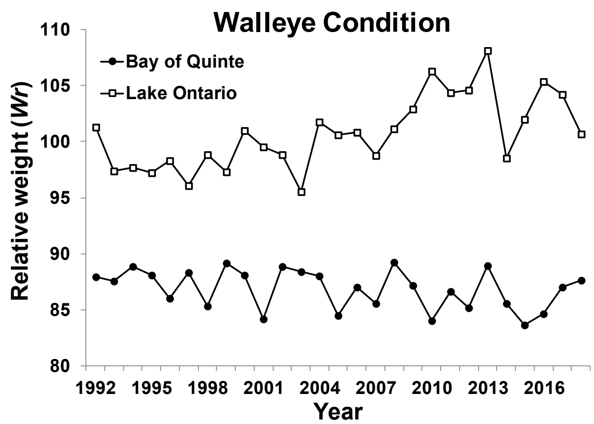


FIG. 7.5.9. Trends in Walleye condition (relative weight), caught in summer assessment gill nets in the Bay of Quinte (fish <500 mm fork length) and Lake Ontario (fish >500 mm fork length), 1992-2018.

Walleye Stocking

Walleye stocking alternates annually between Hamilton Harbour and Toronto Harbour in an effort to re-establish this native, predatory fish and to promote urban, near-shore angling. In 2018, 1 million swim-up fry and 82,176 summer fingerlings were stocked in May and July respectively into Hamilton Harbour (see Sections 6.1 and 8.6).

Overall Status

The overall status of Lake Ontario Walleye is good. The Bay of Quinte/eastern Lake Ontario population did decline during the 1990s but stabilized at levels that supports a high quality fishery including trophy fish (see Section 2.3). Recent recruitment levels forecast a healthy population over the next several years.

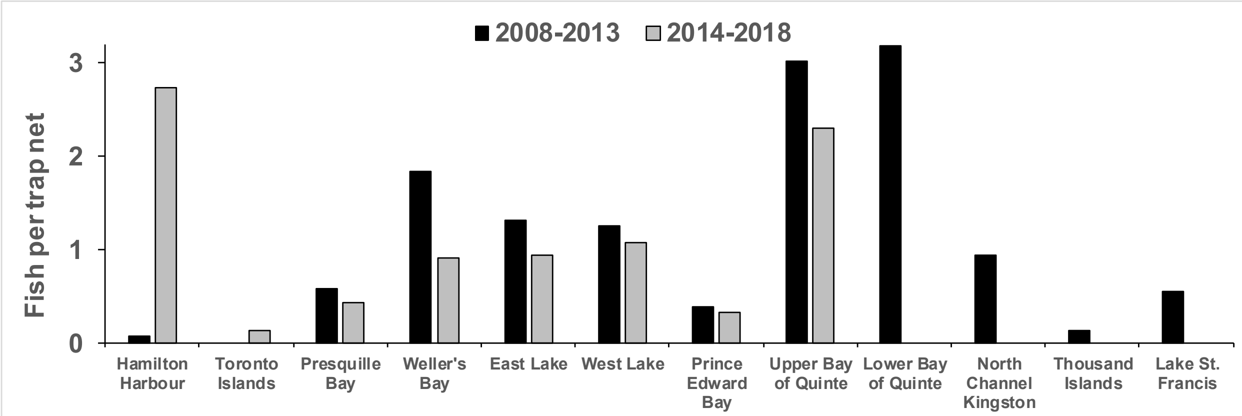


FIG. 7.5.10. Walleye abundance (mean annual number of fish per trap net) in 12 geographic nearshore areas of Lake Ontario and the St. Lawrence River arranged from west (Hamilton Harbour) to east (Lake St. Francis). Catches are annual means for all sampling from 2008-2013 and 2014-2018 time-periods with individual areas having been sampled from one to six years within a time-period. No sampling in the later time -period for Lower Bay of Quinte, North Channel/Kingston, Thousand Islands and Lake St. Francis.

7.6 Yellow Perch

J. A. Hoyle and E. Brown, Lake Ontario Management Unit

Yellow Perch is one of the most ubiquitous and abundant species in the Lake Ontario and St. Lawrence River warm and coolwater fish community (see Sections 1.1, 1.2, 1.3 and 1.9). The species support important recreational and commercial fisheries (see Sections 2.2 and 3.2), and are prey for nearshore predators.

Recreational Fishery

The most significant Yellow Perch recreational fishery occurs on Lake St. Francis, below the Cornwall dam on the St. Lawrence River. The 2018 angling survey of this fishery estimated that anglers caught and harvested 175,103 (7.3 perch per hour by anglers targeting Yellow Perch) and 79,691 perch, respectively from May 5 to Oct 5 (see Section 2.2). Catch and harvest declined more than 40% compared to the last angling survey conducted in 2013. On the Bay of Quinte in northeastern Lake Ontario, large numbers of Yellow Perch are caught by anglers that are otherwise primarily targeting Walleye. In a 2017 open-water angler survey on the Bay of Quinte, an estimated 261,747 perch were caught (2.1 perch per hour for anglers targeting Yellow Perch) but only 16,497 were harvested.

Commercial Fishery

Yellow Perch was the most important species, in terms of both total weight (99,545 lb) and landed value ($167,725), in the 2018 Lake Ontario and St. Lawrence River commercial fisheries (see Section 3.2). Most of the harvest was taken in the Bay of Quinte and the St. Lawrence River. Total annual Yellow Perch commercial harvest declined to a low point in 2015 and commercial quota was decreased in 2016 and again in 2017. Harvest and landed value increased in 2016 and 2017 and then declined sharply in 2018 (Fig. 7.6.1). The 2018 decline is attributed to poor markets and low fishing effort during spring 2018. For example, commercial Yellow Perch gill net effort in 2018 declined by 62% compared to the previous year (Fig. 7.6.2).

Abundance

Yellow Perch abundance is assessed in a number of index netting programs (see Sections 1.1, 1.2, 1.3 and 1.9). Long-term trends in Yellow Perch biomass in assessment gillnets (Section 1.1) is shown in Fig. 7.6.3. Overall biomass was low through the 2012 to 2015 time-period and increased in 2016 and again in 2017. Biomass declined in 2018.

Abundance targets set in the Bay of Quinte FMP (Fisheries Management Plan) for the Bay of Quinte and eastern Lake Ontario are shown in Fig. 7.6.4. Yellow Perch abundance is currently below target values in both areas, particularly in eastern Lake Ontario; abundance appears to be increasing in the Bay of Quinte.

Yellow Perch abundance in Lake St. Francis, St. Lawrence River decreased in 2018 and has now declined steadily since 2010 (see Section 1.9, Fig, 1.9.3).

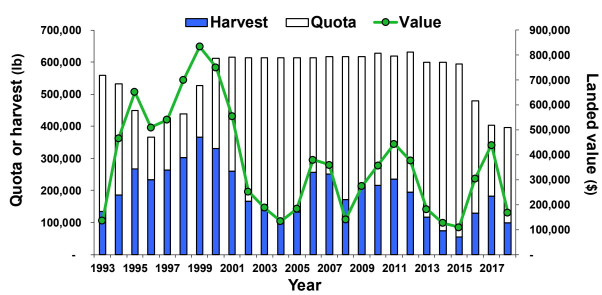


FIG. 7.6.1. Yellow Perch commercial harvest, quota and landed value trends for Lake Ontario (including East and West Lakes) and the St. Lawrence River, 1993-2018.

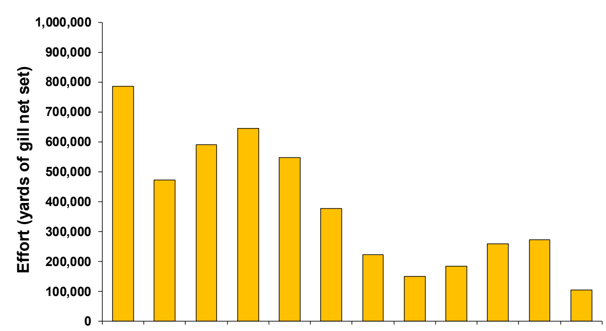


FIG. 7.6.2. Yellow Perch commercial gill net effort for quota zones 1 -2 and 1-4, 1993-2018.

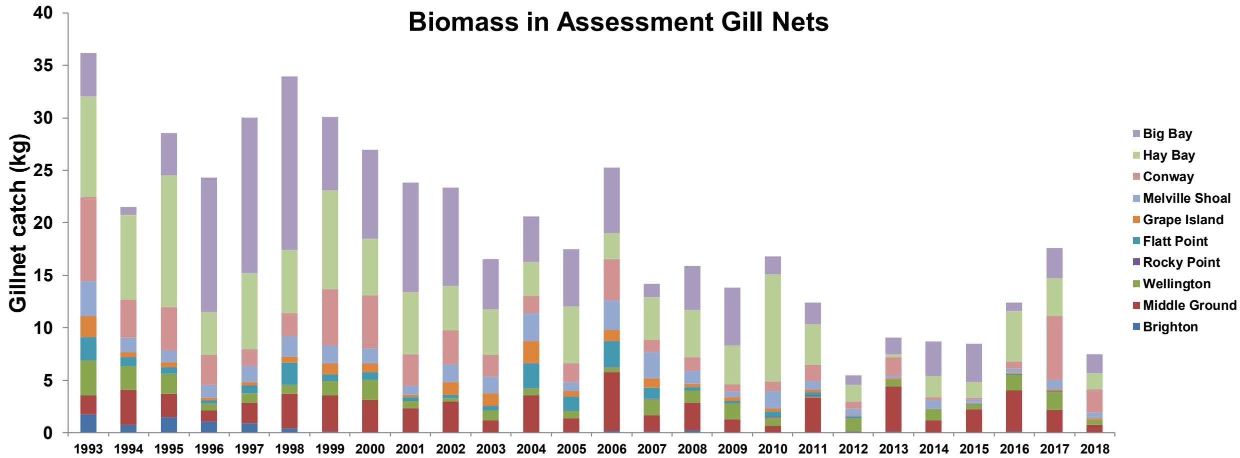


FIG. 7.6.3. Yellow Perch biomass trends at multiple sampling areas in eastern Lake Ontario (from Brighton in central Lake Ontario east to Melville Shoal near the mouth of the St. Lawrence River) and the Bay of Quinte, 1993-2018. See map in Section 1.2 (Fig. 1.1.1).

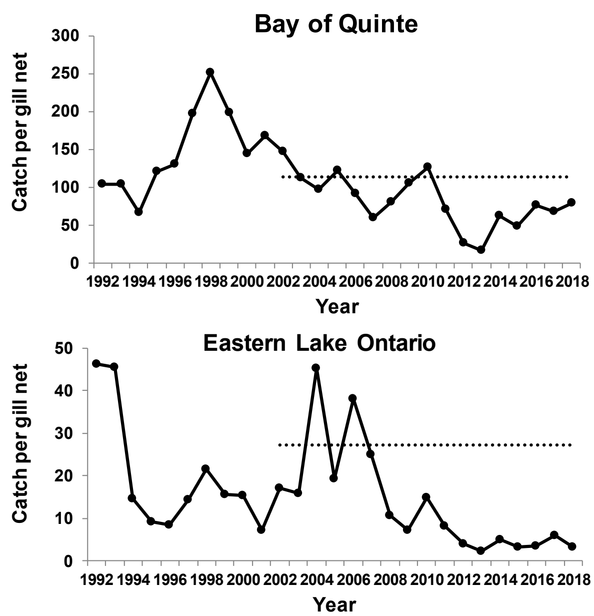


FIG. 7.6.4. Yellow Perch abundance trends in the Bay of Quinte and eastern Lake Ontario, 1992-2018. Also shown (dotted lines, 2002-2018) are target abundance levels established in the Bay of Quinte FMP (Fisheries Management Plan).

7.7 Northern Pike

J. A. Hoyle and E. Brown, Lake Ontario Management Unit

Northern Pike is a common coolwater top predator in the Lake Ontario and St. Lawrence River nearshore fish community. Widespread and long-term declines in pike abundance has been observed. The species is utilized in recreational and commercial fisheries.

Recreational Fishery

The Bay of Quinte open-water recreational fishery was last assessed in 2017. This fishery is largely targeted toward Walleye with about 5% of the total fishing effort targeted at Northern Pike. About 5,000 pike were caught and about 500 harvested in the 2017 fishery. The 2018 Lake St. Francis angling survey (see Section 2.2) estimated that 1,444 Pike were caught and 245 harvested.

Commercial Fishery

Northern Pike is managed as an incidental harvest (i.e. non-targeted) fishery. In 2018, commercial harvest was 10,555 lb with a landed value of $3,764 (Table 3.2.4). Highest pike harvest came from quota zone 1-3, the Bay of Quinte. Northern Pike harvest declined significantly in 2018 due to implementation of a harvest restriction (i.e., no harvest) during April, pike spawning season.

Abundance

Northern Pike abundance is assessed in a number of index netting projects (see Sections 1.1, 1.3, and 1.9). A standard trap net program (Nearshore Community Index Netting; see Section 1.3) regularly samples a variety of embayments and nearshore areas in Lake Ontario and the St. Lawrence River. Mean Northern Pike trap net catches (2008-2013 compared to 2014-2018 time-periods) in 12 geographic nearshore areas are shown in Fig. 7.7.1. Highest pike abundance occurs in Prince Edward Bay, Toronto Harbour, the Thousand Islands and the Lower Bay of Quinte.

Abundance targets set in the Bay of Quinte FMP (Fisheries Management Plan) for the Bay of Quinte and eastern Lake Ontario are show in Fig. 7.7.2. Northern Pike abundance is currently below target values in the Upper Bay of Quinte.

Index gill netting in Lake St. Francis (See Section 1.9, Table 1.9.1) shows a long term decline in pike abundance.

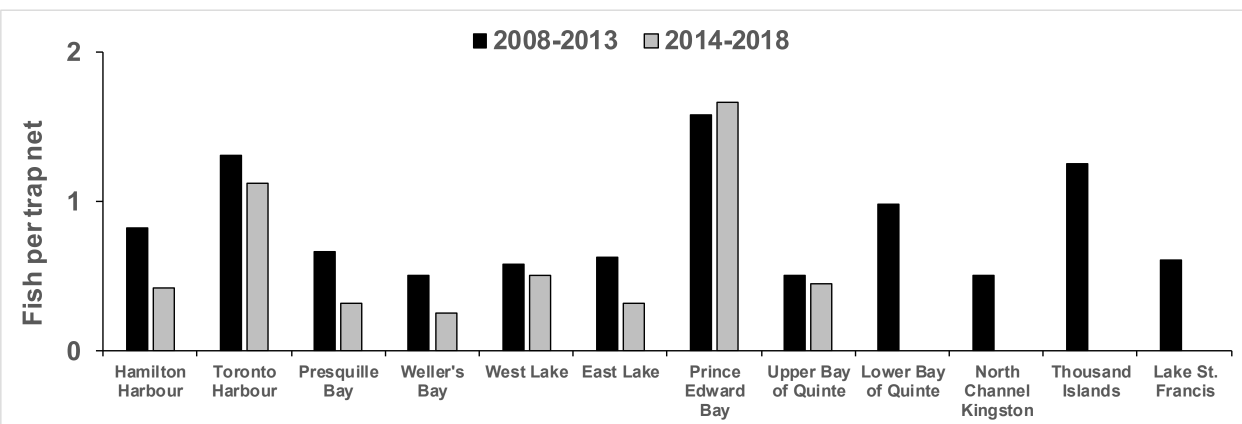


FIG. 7.7.1. Annual mean Northern Pike catch per trap net (standard Nearshore Community Index Netting program) in nine nearshore areas of Lake Ontario. The number of years sampled from 2006 to 2018 is indicated (base of vertical bars).

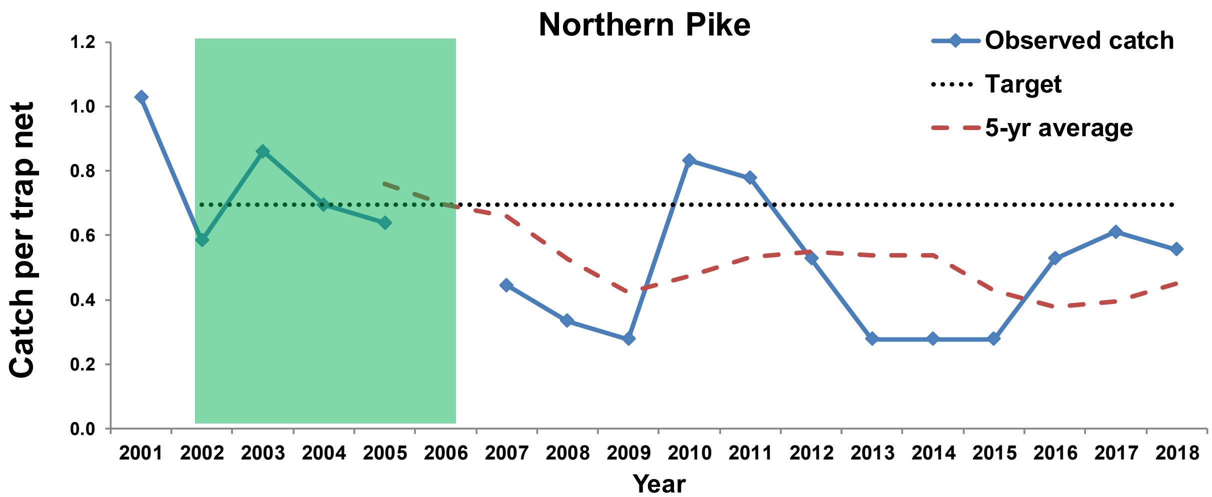


FIG. 7.7.2. Northern Pike catch per trap net in the Upper Bay of Quinte Nearshore Community Index Netting (NSCIN) trap net program, 2001 to 2018 (no netting in 2006). The Northern Pike "target" catch per trap net is shown as the black dotted line, and was determined as the mean catch per trap net during the 2002 to 2006 baseline time-period (green shaded area) as identified in the Bay of Quinte FMP (Fisheries Management Plan). Also shown is the five-year running average pike catch per trap net as the red dashed line (e.g., 2018 point is average of the five years from 2014 to 2018).

7.8 Prey Fish

J. P. Holden, Lake Ontario Management Unit
B. C. Weidel, Lake Ontario Biological Station, USGS
M. J. Connerton, Cape Vincent Fisheries Station, NYSDEC

Managing Lake Ontario fisheries in an ecosystem-context requires prey fish community and population data. The abundance of current and future prey fish resources provides important context for establishing Salmon and Trout stocking levels and managing for sustainable recreational fisheries.

The historical prey fish community was thought to have been dominated by cisco species (Cisco and deepwater forms such as Bloater). Alewife and to a lesser extent, Rainbow Smelt have been the dominant species throughout the modern era (1900s to present). The offshore benthic fish community was largely a mix of sculpin species (Deepwater, Spoonhead and Slimy Sculpin) while Spottail Shiner, Johnny Darter, and Trout-perch were abundant closer to shore. The recent establishment of Round Goby and recovery of Deepwater Sculpin populations have further changed the diversity within the benthic prey fish community.

Bottom trawls have been the primary prey fish assessment gear for the majority of the data series. Bottom trawling in the Bay of Quinte and Kingston Basin has been conducted annually (except 1989) since 1963 (Section 1.2 for additional details). In US waters, an extensive, multi-season trawl program began in 1978. These programs operated independently of each other for most of the survey history. In 2015, the U.S. fall trawl program was expanded to a whole-lake survey with the addition of multiple sites in Canadian waters conducted by OMNRF and USGS (Section 1.8). The US spring survey was similarly expanded in 2016 (Section 1.7). The acoustic program has supplemented Alewife and Rainbow Smelt assessment since 1997 with a greater emphasis on conducting mid-water trawling targeting Cisco and Bloater beginning in 2016 (Section 1.6).

Alewife

Alewife are the dominant prey fish in Lake Ontario and are the primary prey item for important pelagic predators (e.g. Chinook Salmon, Rainbow Trout) as well as other recreationally important species such as Walleye and Lake Trout. It is important to monitor Alewife abundance because significant declines in their abundances in Lakes Huron and Michigan lead to concurrent declines in Alewife-dependent species such as Chinook Salmon. However, having Alewife as the principal prey item can lead to a thiamine deficiency in fish that eat Alewife, which has been linked to undesirable outcomes like reproductive failure in Lake Trout due to Early Mortality Syndrome (EMS).

The adult Alewife (age-2 and older) abundance index for U.S. waters decreased in 2018 (1011 Alewife per 10-minute tow) relative to 2017 (1663 per 10-minutes) and was below the 10-year average (10-yr average = 1880 per 10-minutes, Fig. 7.8.1). In contrast to the U.S. index, an adult Alewife index for trawls in Canadian waters increased in 2018 relative to 2017 (Fig. 7.8.1). Since the spring survey was expanded into Canadian waters, the U.S. and Canadian indices have trended in opposite directions. Given the alternating trends between the U.S. and Canadian Alewife indices, it is important to consider both when interpreting the Lake Ontario Alewife population trends. As predicted, the large 2016 Alewife year-class (which was age-2 in 2018 (Fig. 7.8.2) and counted towards the adult index) increased the overall adult Alewife biomass, however at the time of sampling in April 2018, much of the adult population was in Canadian waters (Table 7.8.1, Figure 7.8.3). This apparent strong spatial variability in Alewife habitat use in April further emphasizes the need for whole-lake approaches to Lake Ontario fish sampling. The mechanisms contributing to the different spatial distribution across years are unknown.

The 2018 age-1 Alewife abundance index for U.S. waters (111 Alewife per 10-minute trawl) was substantially smaller than 2017 (3924) which was the highest figure observed in U.S. waters since the trawl survey adopted its current trawl design in 1997. The 2018 U.S. waters Age-1 index value was the third lowest observed since 1997 with lower values only in 2015 (16 fish per 10 minute tow) and 1997 (62 fish per 10-minute trawl). The index value in Canadian waters was also lower in 2018 (911) relative to 2017 (1012 fish per 10 minutes) but was higher than the U.S. indices. The relatively cool 2017 spring and cold winter likely contributed to the lower than average 2017 year-class since both spring and winter temperature has been shown to influence Alewife reproduction success.

TABLE 7.8.1. Lake Ontario Alewife biomass estimates in kilograms per hectare based on the spring bottom trawl survey. Whole lake figures are based on 52% of the lake area in Canada and 48% in U.S. waters.

Year	U.S.	Canada	Whole Lake
2016	32.0	60.1	46.6
2017	50.8	12.2	30.7
2018	21.5	44.9	33.7

Other Pelagic Fishes

Bottom trawl abundance indices for other pelagic species noted in fish community objectives (Threespine Stickleback, Rainbow Smelt, Emerald Shiner) either declined or remained at low levels in 2018 (Fig. 7.8.4). Rainbow Smelt abundance, while still the second most abundant pelagic species, declined through the 2000s but appears to have established a new lower equilibrium. Threespine Stickleback catches were high for a brief period in the late 1990s but are now caught only infrequently. Emerald Shiner catches have had brief periods of moderately higher abundance however their catches in the trawl surveys are generally quite low even at peak abundance.

Deepwater Sculpin

In 2018, Deepwater Sculpin were among the most abundant benthic prey fishes in Lake Ontario however their biomass estimates declined slightly from 2017 (Fig. 7.8.5). Interestingly, 9 of the 37 trawls that captured Deepwater Sculpin in the fall survey contained dead Deepwater Sculpin (24%). Deepwater Sculpin condition has been declining as their abundance increased over time (Fig. 7.8.6). Together these observations suggest that the Deepwater Sculpin population may be nearing carrying capacity in Lake Ontario and we would expect density and biomass to stabilize or decline slightly.

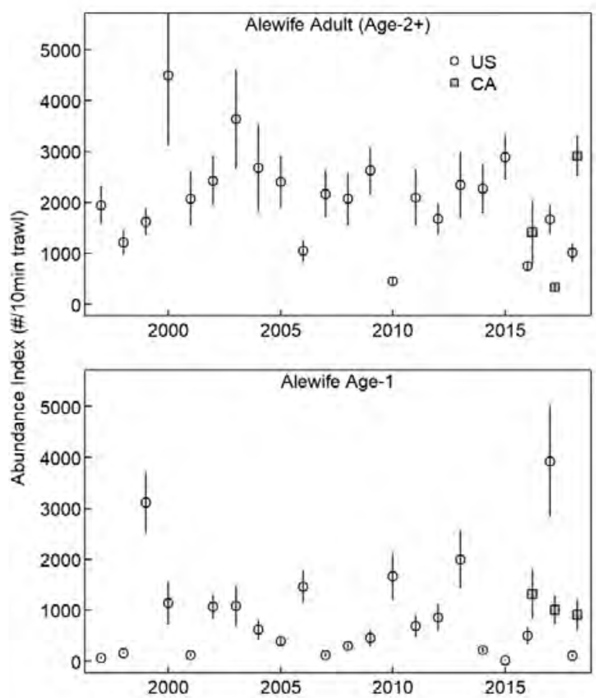


FIG. 7.8.1. Lake Ontario spring bottom trawl-based abundance indices for adult Alewife (age-2 and older, top panel) and Age-1 Alewife (bottom panel). Values represent a stratified, area weighted mean number of Alewife captured in a 10 minute trawl. Error bars represent a standard error of the mean. Trawling in Canadian waters was included in 2016 but to maintain comparisons, separate indices are illustrated for Canadian and US waters which constitute 52% and 48% of lake by area respectively.

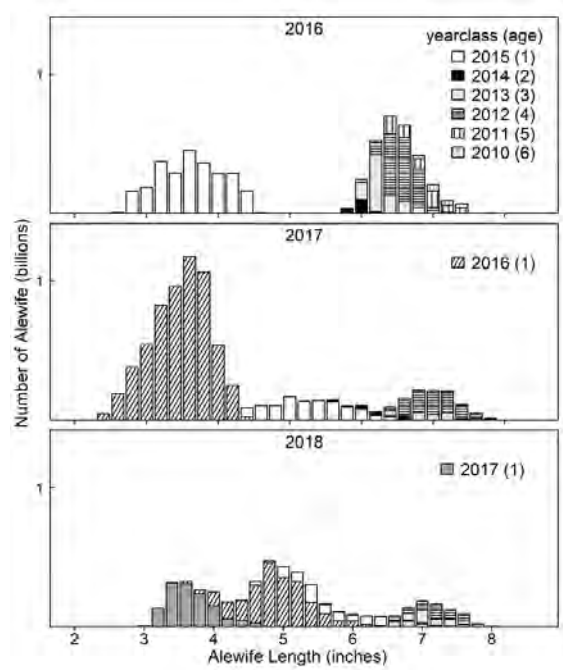


FIG. 7.8.2. Alewife size and distributions from spring bottom trawl surveys conducted in US waters of Lake Ontario, 2014-2018. Each Alewife year-class (all the fish born in a given year) are represented by a consistent color or pattern. The catch of age-1 fish in 2017 (2016 year-class, bottom panel) was the largest ever observed in the survey.

Slimy Sculpin

Slimy Sculpin abundance indices in 2018 were among the lowest observed for the entire time series (Fi. 7.8.5). Once the dominant benthic prey fish in Lake Ontario, Slimy Sculpin declines in the 1990s were attributed to the collapse of their preferred prey, the amphipod Diporeia. The declines that occurred in the mid-2000s appear to be related to Round Goby. Since Round Goby numbers have increased the proportion of juvenile Slimy Sculpin in the total catch of Slimy Sculpins dropped from ~10% to less than 0.5%. Round Goby could be limiting Slimy Sculpin reproduction or possibly recruitment of juvenile Slimy Sculpin to adult stages.

Round Goby

Round Goby density increased in 2018 relative to 2017 for both the U.S. abundance index and the whole lake index (Fig. 7.8.5). Estimating Round Goby abundance using bottom trawls can be complicated by the fish's preference for rocky substrate and seasonal changes in depth distribution. Round Goby were captured during the US spring trawl survey as early as 2002, however that survey's trawl is likely less effective at capturing Goby since the foot rope is elevated off the lake bottom.

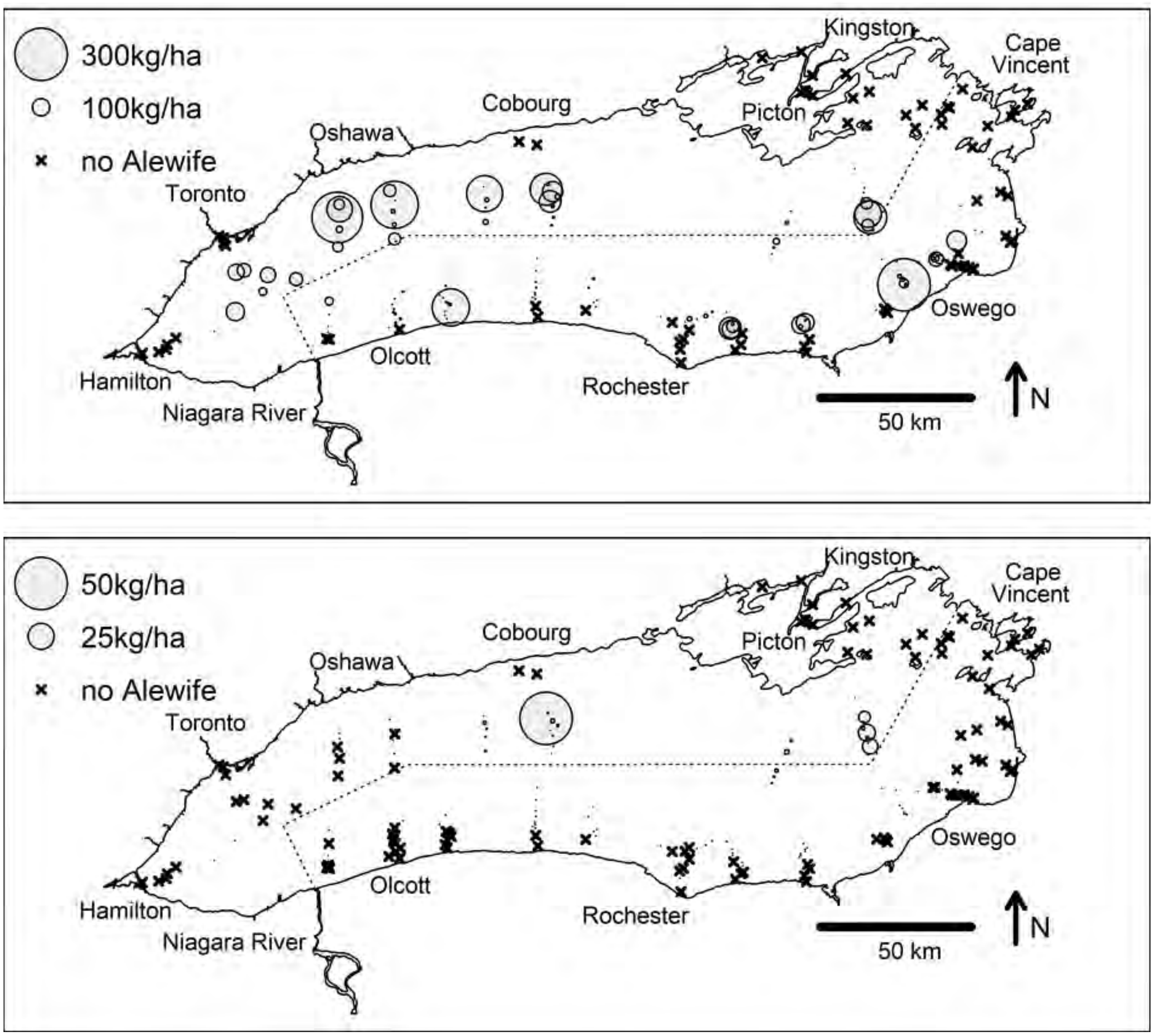


FIG. 7.8.3. Location and biomass of age-2 (top panel) and age-1 (bottom panel) Alewife caught in the 2018 Lake Ontario spring bottom trawl survey collaboratively conducted by USGS, NYSDEC, and OMNRF. The size gray circles represent the relative biomass of Alewife captured while an "x" signifies a location where no Alewife were captured (top panel) or where no age-1 Alewife were captured (bottom panel).

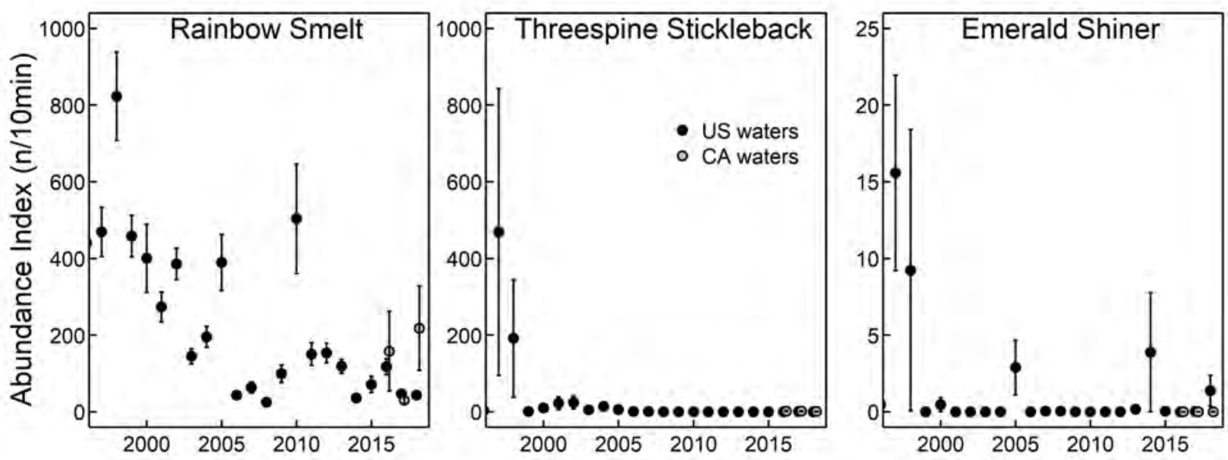


FIG. 7.8.4. Abundance indices for other Lake Ontario pelagic prey fishes based on bottom trawls in U.S. and Canadian waters, 1997-2018. Error bars represent one standard error.

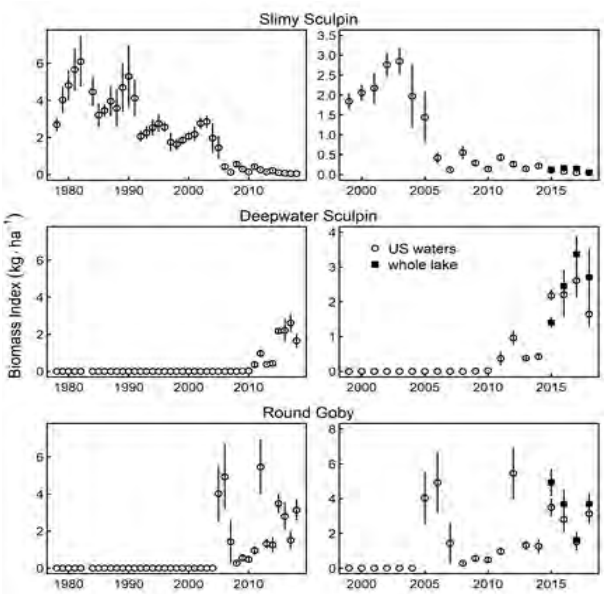


FIG. 7.8.5. Lake Ontario prey fish trends for demersal or bottom-oriented species from 1978-2018 (left panels) and 2008-2018 (right panels). Survey is conducted in late-September and early-October and error bars represent one standard error. Sampling in Canadian waters began in 2015. Separate 20m stratified, lake area-weighted means are calculated separately for tows in US and Canadian waters to maintain comparability across the US index time series.

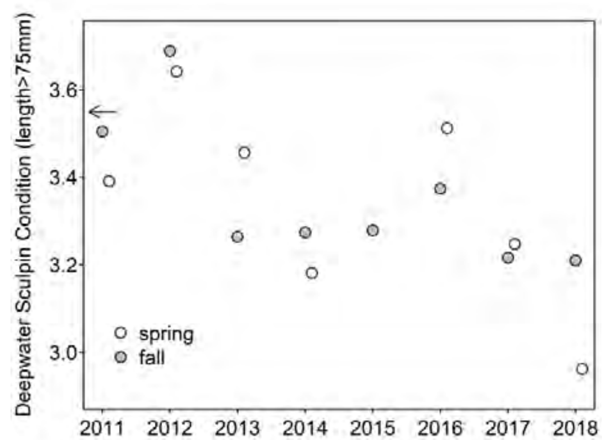


FIG. 7.8.6. Deepwater Sculpin 'condition' as measured by the slope of the relationship between log total length (mm) and log weight (g). When fish are heavier at a given length the y-axis value is higher, when fish are lighter at a given length the value is lower. For reference the arrow represents a value from Lake Superior Deepwater Sculpin from the 1970s.

7.9 Cisco

J. P. Holden, J. A. Hoyle and E. Brown, Lake Ontario Management Unit
B. C. Weidel, Lake Ontario Biological Station, USGS
M. J. Connerton, Cape Vincent Fisheries Station, NYSDEC

Historically, Cisco were thought to be the dominant native pelagic prey fish species in Lake Ontario prior to European colonization. Even throughout the early part of the 20th century Cisco supported important commercial fisheries. Cisco are the only remaining form of a diverse flock of Coregonus sp. that historically included four other forms in Lake Ontario. At present Cisco represent only a small fraction of the lake-wide pelagic prey fish community. Population dynamics show declining commercial catches from the 1950s. All surveys show an increase in abundance in the late 1980s to early 1990s followed by a period of low abundance. The most recent years indicate a period of higher abundance (Fig. 7.9.1). At present, Cisco are geographically limited to the eastern portion of Lake Ontario (Fig. 7.9.2) despite Hamilton Harbour being a known historical spawning embayment.

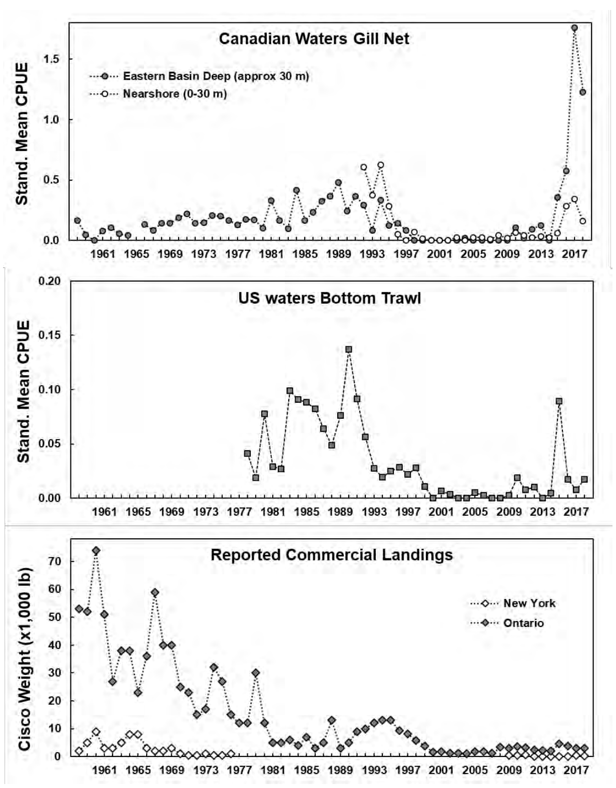


FIG. 7.9.1. Lake Ontario Cisco time series including gill net catch per unit effort for two Canadian waters surveys, bottom trawl catch per effort from US waters and commercial harvest statistics for Ontario and New York.

Fish community changes had already occurred before the establishment of the current assessment programs. Therefore, we lack historical catch per unit effort (CPUE) information from when Cisco dominated the system to provide context to contemporary CPUE. Midwater trawling conducted from 2016 to 2018 (Section 1.6) has provided a more targeted assessment program and greatly increased the number of Cisco captured in assessment programs and provided a comparable biomass estimate to other Great Lakes. Current biomass (< 1.0 kg/ha) are well below Lake Superior (5.5 kg/ha) where Cisco still dominate the fish community.

One hundred and sixteen Cisco were caught and interpreted for age in the 2018 Lake Ontario Fish Community Index Gill Netting (Section 1.1). Fish ranged in age from 1-16 years and represented fourteen year-classes. Contribution from the 2014 year-class as represented by index gill net catches continues to be significant (Fig. 7.9.3).

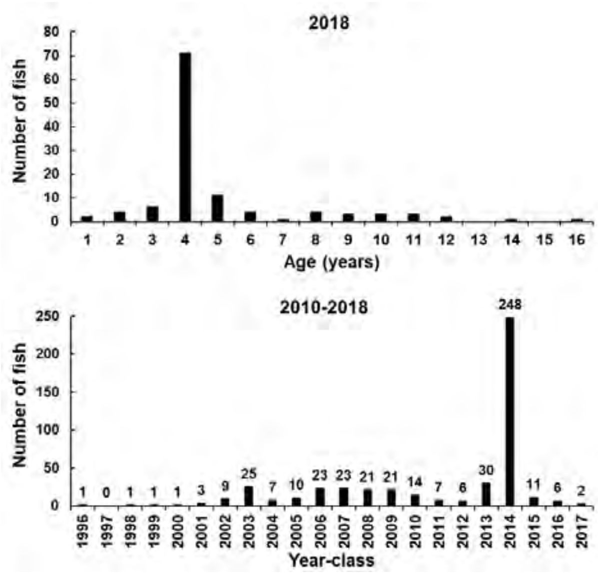


FIG. 7.9.3. Upper panel: Cisco age distribution in 2018 Lake Ontario Fish Community Index Gillnetting. Lower panel: Cisco yeas-class contribution to total Cisco catch from 2010-2018 Lake Ontario community index gill nets (see Section 1.1).

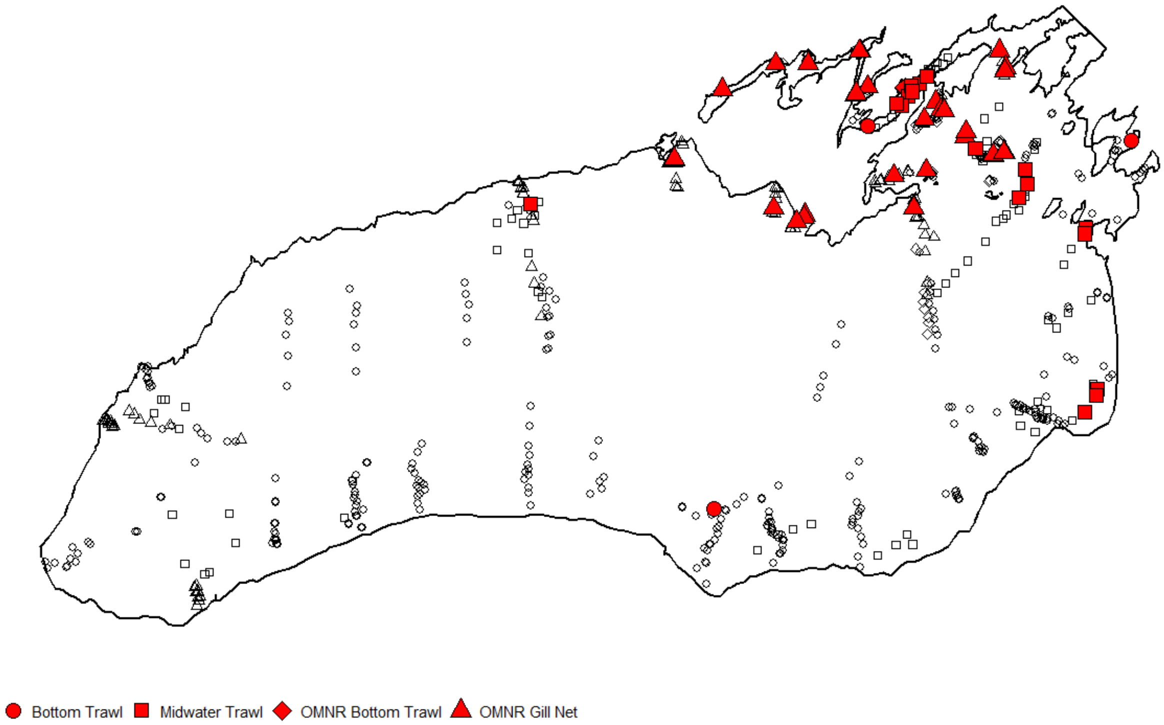


FIG 7.9.2. Extent of fish community sampling conducted in 2018 by the Lake Ontario Management Unit. Bottom trawl and Midwater trawl surveys are conducted in partnership with USGS and NYSDEC. Sampling occurred throughout the entire open water season using gill nets, bottom trawls (2 different styles) and midwater trawls. Open shapes indicate no Cisco captured at a sampling event. Filled shapes are scaled to number caught.

8. Species Rehabilitation

8.1 Introduction

A. Mathers and A. Todd, Lake Ontario Management Unit

Lake Ontario has a long history of fish community change caused by introduced species (intentional and unintentional), overfishing, habitat loss, industrial development and pollution. OMNRF works with many partners - government agencies, non-government organizations and interested individuals at local, provincial and national levels - to enhance Lake Ontario fish community fisheries through native species rehabilitation.

Actions to rehabilitate native species include fish stocking, habitat enhancement, fish passage, fish community monitoring and research and management to ensure sustainable harvest though regulations. Rehabilitation efforts are occurring across the Lake Ontario basin including the embayments, tributaries and the lower Niagara River and the St. Lawrence River downstream to the Quebec-Ontario boarder.

The sections below describe initiatives to restore Atlantic Salmon, American Eel, Bloater, Lake Trout, Walleye and Lake Sturgeon. Some of these species have been extirpated, while others were once common but are now considered rare, at least in some locations in the lake. Successful restoration of these native species will enhance the overall health of the fish community and support fisheries that provide economic and social benefits to Ontario. Native species restoration also contributes to improving Ontario's biodiversity and meeting Ontario's commitments under the GLFC's Fish Community Objectives and commitments identified in the Great Lakes Water Quality Agreement.

8.2 Atlantic Salmon Restoration

M. D. Desjardins, Lake Ontario Management Unit

Atlantic Salmon were extirpated from Lake Ontario by the late 1800s, primarily as a result of spawning and nursery habitat loss in streams. As a top predator, they played a key ecological role in the offshore fish community. They were also a valued food resource for aboriginal communities and early Ontario settlers. As such, Atlantic Salmon are recognized as an important part Ontario's natural and cultural heritage.

Originating as a small stocking program in 1987, the Lake Ontario Atlantic Salmon Restoration Program has developed into a significant partnership combining the efforts of the Ontario Ministry of Natural Resources and Forestry (OMNRF), the Ontario Federation of Anglers and Hunters (OFAH), and many corporate and community partners. Since 2006, significant progress has been made through enhancements in fish production, community involvement, research and assessment, and habitat enhancement.

In 2015, the program steering committee developed a revised five-year plan (2016-2020) with new priorities and performance measures designed to accelerate restoration with emphasis on improving adult returns. One facet of the revised restoration program was the creation of a recreational fishery in Lake Ontario tributaries. To implement this objective, catch and release Atlantic Salmon seasons were implemented in zones 16 and 17 in 2016 and a portion of our current restoration stocking allotment has been allocated toward the Ganaraska River to create an Atlantic Salmon destination fishery. Since 2016, roughly 50 thousand yearling Atlantic Salmon have been stocked annually in the Ganaraska River (Section 6.1).

To help monitor success of this initiative, a trial volunteer Atlantic Salmon angler survey was initiated during 2018 with a full angler survey slated for delivery across multiple watersheds in 2019. Progress is also being tracked with the help of a new "state of the art" fish counter / camera system (known as the Riverwatcher fish counter) that has been installed in the fishway on Corbett's Dam (Section 1.4). In 2018, the Lake Ontario Management Unit installed a Riverwatcher fish counter on the Credit River at the Reid Milling Dam (a.k.a. Streetsville Dam; Section 1.5). This new technology provides better surveillance of the Atlantic Salmon spawning run and provides valuable information on the migratory patterns for other species ascending the Ganaraska and Credit Rivers. Information from these programs have documented a baseline presence of adult Atlantic Salmon in these rivers.

The Ganaraska River Riverwatcher fish counter monitored fish passage events from March 26 to November 22, 2018. The first Atlantic Salmon observed at the Ganaraska Fishway in 2018 was on July 27th. From that time until September 12th, 2018, 13 Atlantic Salmon were identified moving upstream from the Corbett Dam (Section 1.4; Fig. 1.4.13). Due to technical difficulties, data recorded via the fish counter after September 11, 2018 have not been subject to quality control, quality assurance and species identification procedures.

The Credit River Riverwatcher fish counter monitored fish passage events from August 14 to November 15, 2018. During the monitoring period, the Streetsville Riverwatcher documented a total of five Atlantic Salmon, the first on August 30th, 2018 (Section 1.5; Fig. 1.5.8). Atlantic Salmon have been known to migrate upstream as early as June in Lake Ontario tributaries, so the full migratory run on the Credit River was not evaluated in 2018. Monitoring and assessment of migratory salmon and trout utilizing the Streetsville Fishway will continue in 2019, incorporating the entire ice-free season from late-March to November.

Additionally, LOMU and Fish Culture Staff caught six adult Atlantic Salmon and observed more throughout October during the Chinook Salmon egg collection. On October 19, 2018, five adult Atlantic Salmon were caught and more observed in a single pool below the Streetsville Fishway (Fig. 8.2.1). Four additional adult Atlantic Salmon were observed by Aurora District staff on November 10 and 17, 2018, below the Streetsville Fishway during Coho Salmon Egg

Collection. These observations along with many anecdotal reports of adult Atlantic Salmon returning to multiple Lake Ontario tributaries are encouraging.

FIG. 8.2.1. OMNRF Fish Culture Staff with five adult Atlantic Salmon caught at the Credit River, October 18th 2018.

8.3 American Eel Restoration

A. Mathers, Lake Ontario Management Unit

Background

The American Eel (*Anguilla rostrata*) was historically an important predator in the nearshore fish community of Lake Ontario and the upper St. Lawrence River (LO-SLR). They also functioned as an important component of the LO-SLR commercial fishery during the latter part of the 20th century and are highly valued by indigenous peoples. American Eel abundance declined in the LO-SLR system as a result of the cumulative effects from a variety of factors including: mortality during downstream migration due to hydro-electric turbines, reduced access to habitat imposed by man-made barriers to upstream migration, commercial harvesting, contaminants, and loss of habitat.

By 2004, American Eel abundance in Ontario had declined to levels that warranted closure of all commercial and recreational fisheries in the province. In 2007, American Eel was identified as Endangered under Ontario's Endangered Species Act (ESA). In 2012, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) recommended that American Eel be identified as Threatened under the Canadian Species at Risk Act. These events led to additional efforts to protect and restore the American Eel. This section describes the status of American Eel in LO-SLR as well as actions taken by the Lake Ontario Management Unit (LOMU) and its partners to reverse the decline of American Eel populations in Lake Ontario and the St. Lawrence River.

Indices of Eel Abundance

Moses Saunders Eel Ladder Operation

The largest barriers to both upstream and downstream migration of American Eels into the Lake Ontario system are power dams in the St. Lawrence River. One of these dams, the Moses Saunders Power Dam (MSPD), is located on the upper St. Lawrence River between Cornwall, Ontario and Massena, New York. In 1974, an eel ladder (Saunders Ladder) was put in place on the Ontario portion of the dam to aid in the upstream passage of American Eel. The maintenance and operation of the ladder was accomplished through collaborations between OMNRF and Ontario Power Generation (OPG) until 2007 when OPG took full responsibility for the structure.

In 2018, the Saunders eel ladder was in operation 24 hours a day from June 15 to October 15. Over the course of these four months, passive integrated transponder (PIT) tag readers and an electronic fish counter were used to monitor the use of the ladder and quantify the number of eels passing upstream. The PIT tag reader and counter operated uninterrupted throughout the season. In 2018, a total of 13,877 eels successfully passed through the OPG eel ladder (Fig. 8.3.1). On the night of July 10, the ladder passed 1,198 eels, which represents the highest daily passage of eels over the last 25 years of ladder operation. Most eels passed through the ladder during a six-week period from early July to late August and 98.7% of the eels exited the ladder during hours of darkness from 22:00 to 06:00. These observations are comparable to previous years.

The number of eels passed through the Saunders ladder during 2018 was slightly higher than the number of eel that passed through a second eels ladder (Moses Ladder) on the New York portion of the MSPD, where 10,992 eels successfully exited. The Moses Ladder has been in operation since 2006 and is maintained by the New York Power Authority (NYPA). During 2012 to 2018, the NYPA ladder passed slightly more eels than the OPG ladder and made up 67% of the total number that passed.

The numbers passing up the ladder have been declining annually in recent years and the combined number of eels that passed through both ladders in 2018 (24,869 eels) represents the first increase since 2011. The number of eels ascending the ladders in 2018 is only 2.5% of the level of recruitment identified as a long-term indicator in the Lake Ontario Fish Community Objectives for American Eel (FCO 1.3; at least one million eels ascending the ladders annually).

Biological characteristics were recorded on 1,070 eels collected from the Saunders ladder during 2018. The average length (398.6 ± 69.6 mm, n = 1,070, minimum = 241, maximum = 621) and average weight (100.7 ± 58.1 g, n = 1,070, minimum = 17, maximum = 378) was similar to observations in recent years with a trend for slightly larger fish since 2012. The exotic swim bladder parasite (*Anguillicoloides crassus*) was detected in an eel moving up the ladder. This fish was a natural migrant and represents the first occurrence of this parasite in a Lake Ontario eel that was not stocked into the system.

Lake Ontario and Upper St. Lawrence River Assessment programs

In 2018, the abundance of larger "yellow" eels in the LO-SLR was measured with several assessment programs. Bottom trawling in the Bay of Quinte has been conducted since 1972 as part of the fish community index program. The average catch of American Eel in 511 trawls conducted (June-September at sites upstream of Glenora) between 1972 and 1996 was 2.0 eels per trawl. No eels were captured in the 360 trawls conducted between 2003 and 2011. Catches of eels have been increasing slightly in recent years with eight eels captured during the fourty bottom trawls conducted during 2018 (Section 1.2).

Nearshore trap netting was conducted using the NSCIN fish community index protocol (see Section 1.3). During 2018, three eels were captured in 24 nets set in Hamilton Harbour, three eels were captured in 24 nets set in Toronto Harbour, and 23 eels were captured in 36 nets set in the Upper Bay of Quinte. This was the highest number of eels observed in the time series for each of these locations.

Tail Water Survey

In 2018, surveys were conducted by OPG to collect dead eels in Canadian waters from the tailwater of the MSPD. The surveys followed standardized routes, which extended approximately 10 km downstream of the dam along the Canadian shoreline. Parallel surveys are conducted in US waters below the MSPD by New York Power Authority (NYPA). Tailwater surveys were conducted twice weekly from June 12 to September 28, 2018. Investigators working in a boat searched the specified area for dead and injured American Eels that were floating or submerged along or near the shoreline. In 2018, OPG observed a total of 85 eels during 32 surveys, an average of 2.7 eels per day, while NYPA observed 1.0 eel per day during their survey of US waters below the MSPD (Fig. 8.3.2). The average length of whole eels (n=36) collected by OPG was 943 ± 72 mm (mean ± SD)

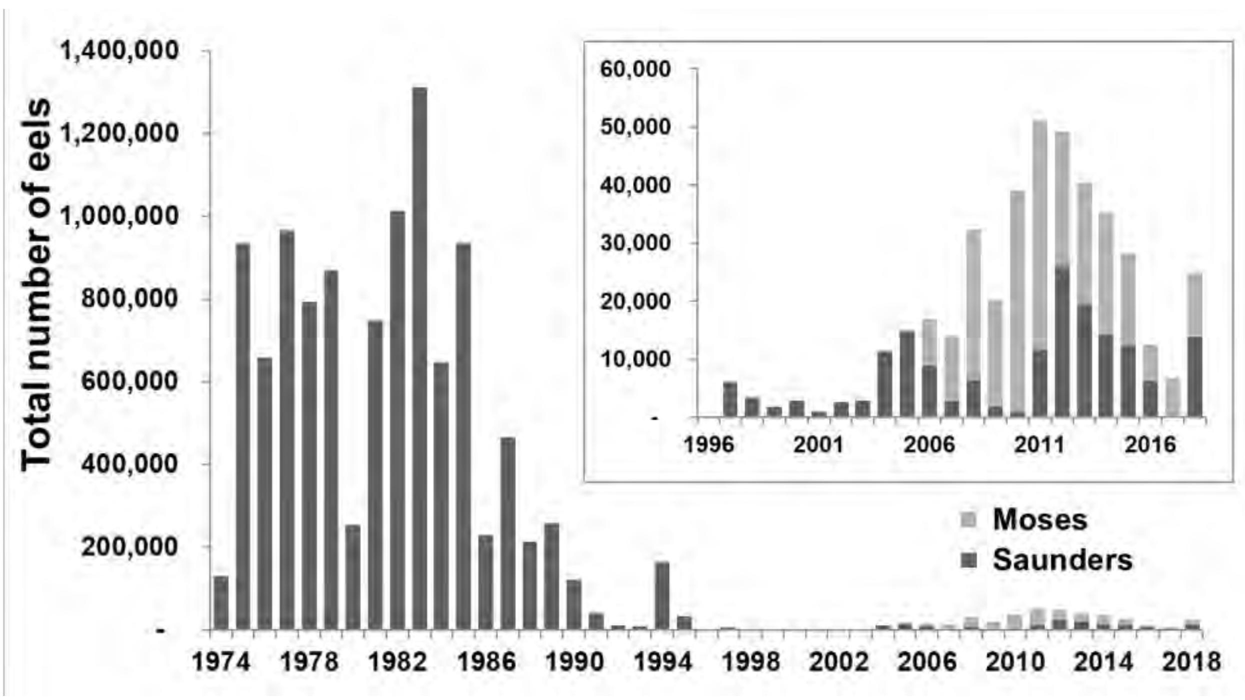


FIG. 8.3.1. Total number of eels ascending the eel ladder(s) at the Moses-Saunders Dam, Cornwall, Ontario from 1974-2018. During 1996, the ladder operated however no counts were made.

(Fig. 8.3.3). Abundance of collected eels was highest in September with 40 eels collected. All eels were collected when water temperatures were greater than or equal to 20°C. These results are like those of previous years, although fewer eels were collected in 2017 (n=35) and 2016 (n=64).

Based on a report from a local angler concerning observations of dead eels downstream of the Moses-Saunders tailwater on November 1, surveys for dead American Eels were also conducted on November 7 and 13, 2018. Twenty-four eels were collected and up to 50 additional eels were observed. Otoliths were obtained from twenty-three of the eels and indicated that all were of stocked origin. Additionally, the presence of *A. crassus* was documented in one eel. This later timing of outmigration by stocked eels is corroborated by outmigration studies on stocked eels conducted in conjunction with the Eel Passage Research Center as well as from landings in the commercial eel fishery in Quebec. In future years, it is suggested that one or two surveys be conducted in the MSPD tailwater after October 31 on a calm and sunny day to further document this outmigration event by stocked eels.

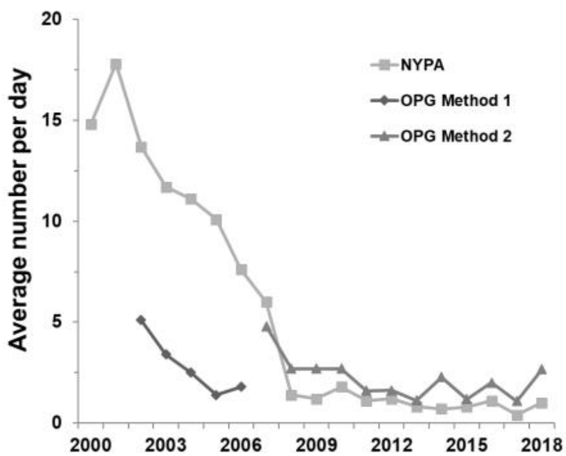


FIG. 8.3.2. Average number of eels observed per day in the tail-waters of the Moses-Saunders Dam 2000-2018. Note that the OPG sampling methodology and route changed in 2007.

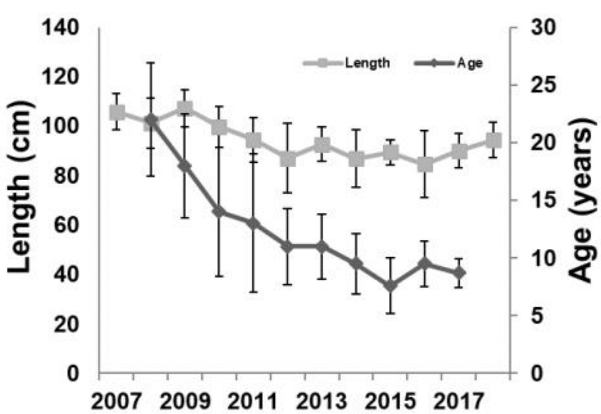


FIG. 8.3.3. Length (mean ± standard deviation) and age (mean ± standard deviation) of eels collected in the tail-waters of the Moses-Saunders Dam 2007-2018.

Restoration Efforts

Trap and Transport

Safe downstream passage past hydro turbines during the eel's spawning migration is an obstacle to restoration of eels that is identified in the OPG Action Plan. "Trap and Transport" (T&T) of large yellow eels was initiated in 2008 as an OPG pilot project to investigate this alternative for mitigating mortality of eels in the turbines at the Saunders Hydroelectric Dam. The project also involved local commercial fishers and the Québec Ministère des Forêts, de la Faune et des Parcs (MFFP). LOMU staff assisted OPG in the collection of eels captured in local commercial fisheries and transport of these fish from LO-SLR to Lac St. Louis (a section of the St. Lawrence River below all barriers to downstream migration). During 2008-2014, only eels collected during the spring commercial fishery were included in T&T. Since 2014, eels collected during the fall commercial fishery were also included in the T&T project to increase the numbers of eels transported.

In 2018 a total of 5,691 large yellow eels (539 and 149 from Lake St. Francis in the spring and fall respectively, and 1,283 and 3,720 from above the Moses-Saunders Dam during the spring and fall respectively) were released into Lac St. Louis immediately downstream of the Beauharnois Hydroelectric Dam as part of the T&T program (Fig. 8.3.4). During release, all T&T eels were observed to be in good health and swam away from the release site and down towards the substrate. The mortality of large yellow eels during both the spring (five eels died) and fall (eight eels died) capture phases of the program was low in 2018. In addition, 154 eels (102 from Lake St. Francis and 52 from above the Moses-Saunders Dam) were provided to the eel passage acoustic telemetry project (Section 9.15).

MFFP Silver Eel Fishery Monitoring

To monitor the long-term survival, condition, maturation and migration of the transported yellow eels, the silver eel fishery was monitored by biologists affiliated with the Quebec MFFP (Verreault and Dussureault 2018). Commercial landings were estimated for the 11 fishers at 20 tons or 12,751 silver eels in 2018. The CPUE was 4.4 kg / m of tidal weir, which is higher than last year. Mean age was estimated at 13.6 (± 3.2) years for naturally-recruited eels and 10.9 (±1.2) years for stocked individuals. Since 2015, the presence of stocked eels is no longer limited to size classes less than 750 mm, the largest stocked individual this year reached a size of 1,037 mm. Verreault and Dussureault estimated that stocked eels constituted 30.3% of downstream migrants, the second highest proportion recorded. These stocked eels originated from approximately 6.8 million elvers stocked in the Richelieu River, the upper St. Lawrence River and Lake Ontario from 2005 to 2010. They expect that the occurrence of stocked eels will increase further over the next few years due to the large number of stocked individuals in the last three years of the experimental program. They also estimated that approximately 28,500 silver eels originating from stocking operations have migrated in the estuary in 2018 thus contributing to increase the reproductive potential of the species. The exotic swimbladder parasite *A.crassus* was found in four eels for a prevalence rate of 1.3% and an mean intensity of 8.8 (± 14.8) parasites. One of the four infected eels was a wild migrant, demonstrating the parasite can complete its life cycle in the St. Lawrence watershed.

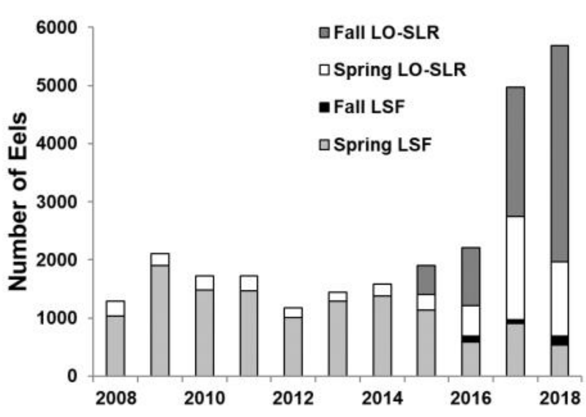


FIG. 8.3.4. Total number of eels collected in the Trap and Transport program from 2008-2018. Each total is divided into the locations at which the eels were captured in commercial fishery nets and the season of collections.

Eel Passage Research Center

Since 2013, the Eel Passage Research Center (EPRC) has conducted research to evaluate potential techniques to concentrate out-migrating eels for downstream transport around turbines at Moses-Saunders and Beauharnois Hydroelectric Dams to mitigate mortality in turbines. EPRC is coordinated by Electric Power Research Institute and primary funders of the research include OPG, Hydro Quebec, and the United States Fish and Wildlife Service (through a funding arrangement from NYPA). EPRC activities during 2018 included:

- Eel Passage Research Center: 2013-2018 Synthesis Report
- A White Paper investigation of the use of sound to guide outmigrating American Eels, *A.rostrata*, near Iroquois Dam and the Beauharnois Power Canal was published in 2018
- Behavioral responses of American and European Silver Eels (*A.rostrata and A.anguilla*) to electric fields under both static and flowing water conditions was published in 2018

Summary

Restoration of American Eel in Lake Ontario and the St. Lawrence River has been identified as a Fish Community Objective for Lake Ontario. The abundance of eels moving into the system via the ladders at the Moses-Saunders Dam and the number of mature eels leaving the system are much lower than the FCO long-term indicators. However, the mortality rate of eels migrating downstream towards the spawning grounds has decreased because of the Trap and Transport project. In addition, a collaborative effort to develop methods of reducing mortality of eels during their downstream migration has been initiated. Although the Fish Community Objective related to American Eels has not been achieved, the activities summarized in this report show that some progress has been made.

8.4 Bloater Restoration

J. P. Holden, Lake Ontario Management Unit

Prior to the mid-1950s, Lake Ontario was home to a very diverse assemblage of deepwater ciscoes including Bloater (*Coregonus hoyi*), Kiyi (*C. kiyi*), and Shortnose Cisco (*C. reighardi*). Currently, only the Lake Herring (*C. artedi*) remains in Lake Ontario. Re-establishing self-sustaining populations of Bloater in Lake Ontario is the focus of a cooperative, international effort between the Ontario Ministry of Natural Resources and Forestry (OMNRF), the New York State Department of Environmental Conservation (NYSDEC), the U.S. Fish and Wildlife Service (USFWS), the U.S. Geological Survey (USGS) and the Great Lakes Fishery Commission (GLFC). The Lake Ontario Committee has set a goal to establish a self-sustaining population of Bloater in Lake Ontario. The objectives and strategies for the establishment of Bloater are specified in a draft strategic plan, which is currently under review. The plan addresses: sources of gametes, culture facilities, culture capacity, stocking, detection of wild fish, increasing our understanding of ecological consequences, research needs, and public education.

Potential long-term benefits of restoring Bloater include restoring historical food web structures and function in Lake Ontario, increasing the diversity of the prey fish community, increasing resistance of the food web to new species invasions, increasing wild production of salmon and trout by reducing thiaminase impacts of a diet based on Alewife and Rainbow Smelt, and supporting a small commercial fishery. Potential risks associated with the reintroduction of Bloater relate to the unpredictability of food web interactions in an evolving Lake Ontario ecosystem. Accepting some risk and uncertainty, doing the necessary science to increase understanding and minimize risk, and adapting management strategies accordingly are prerequisites for successful restoration of Bloater in Lake Ontario.

In 2018, there were 91,000 fall yearling (age-1) Bloater stocked by OMNRF at three stocking locations. Nine thousand yearlings were stocked near Main Duck Island to support ongoing research activities along with an additional 1,100 age-2 fish. Seventy-nine thousand were stocked in south of Cobourg in deep water and 3,000 were stocked in the lower Bay of Quinte near Bath (see Section 6.1). As production numbers increase the stocking strategy will focus on putting these fish in 80 m - 100 m depths south of Cobourg.

While there are no assessment programs specifically targeting Bloater; several of OMNRF programs have the potential to capture and assess Bloater survival and indicate population levels (Fig. 8.4.1) . In 2018, there were no Bloater caught in the 248 gill nets, 102 bottom trawls and 46 midwater trawls conducted in multiple assessment programs in areas where Bloater could have inhabited.

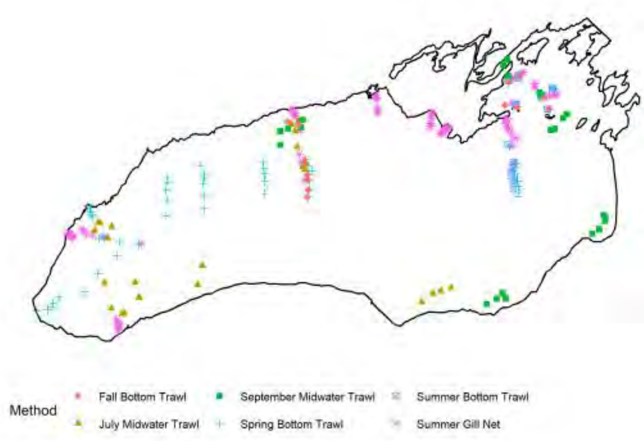


FIG. 8.4.1. Extent of fish community sampling conducted in 2018 by the Lake Ontario Management Unit in areas where Bloater could expect to be found. Sampling occurred throughout the entire open water season using gill nets, bottom trawls (2 different styles) and midwater trawls.

8.5 Lake Trout Rehabilitation

J. P. Holden, Lake Ontario Management Unit

Excessive harvest of Lake Trout began in the 1830s and despite an increase in abundance in the 1920s, harvest and Sea Lamprey predation resulted in Lake Trout being deemed extirpated in Lake Ontario in the 1950s. Rehabilitation of Lake Trout in Lake Ontario began in the 1970s with Sea Lamprey control and stocking of hatchery fish. The first joint Canada / US plan outlining the objectives and strategies for the rehabilitation efforts was formulated in 1983. The two objectives of the recovery strategy are: 1) increase abundance of stocked adult lake trout to a level allowing for significant natural reproduction and 2) improve production of wild offspring and their recruitment to adult stock.

Canadian waters of Lake Ontario have had gill net assessments since the 1950s. Sites within the Kingston Basin (also referred to as the East Basin; the portion of the lake bounded by Prince Edward Bay, Main Duck Island, Amherst Island and the Canada/US border) provide the most consistent long-term index of Lake Trout monitoring in Ontario waters dating back to the 1957. Index gill netting in the main basin of Lake Ontario began in the 1960s but has not been conducted with standard effort and sites throughout the entire period.

Stocking throughout the 1980s was successful in restoring Lake Trout biomass throughout Lake Ontario (Fig. 8.5.1). Ecosystem change, stocking cuts and a period of high Sea Lamprey mortality lead to declines in Lake Trout abundance throughout the 1990s to 2005 (2008 in the main basin). Since 2005 catches in the Ontario waters of the main basin have remained low but exhibit a moderate increasing trend. Within the Kingston Basin, the trend was increasing up until 2015, but has been declining in the most recent years. A summary of progress towards restoration targets is included in Table 8.5.1.

An increase in spatial coverage in gill net sites in recent years provides an opportunity to compare geographical differences in Lake Trout abundance (Fig. 8.5.2). Catches are highly variable at all sites with a five-year mean catch-per-unit-effort (CUE) of 2.2 fish per 24 hr set of standardized index gill net (min. = 0.0, max. = 17.0) (Fig. 8.5.3). Port Dalhousie, added in 2018, is a notable outlier among the other areas with a mean catch rate of 11.1 (median CUE = 12.9) compared to a mean CUE of 2.2 (median CUE = 1.1) for all sites combined.

TABLE 8.5.1. Status of Ontario targets identified in the Lake Trout Management Plan.

Management Strategy	Status	Details
Stock 500,000 spring yearlings per year in Canadian waters	Below	Lake Trout stocking target was reduced to 363,000 for 2018
Maintain an adjusted catch rate of age-3 fish per standard gill net per 500,000 stocked > 1.5 fish per standard gill net set	Below	Currently below target but has shown an increasing trend since 2012 (Fig. 8.5.4)
A relative abundance greater than a CUE of 1.1 female Lake Trout > 4000g per standardized gill net	Below	Increasing trend but still well below target (Fig. 8.5.5)
Yearly survival of adult fish > 60%	Met	Survival of ages 5 to 15 has averaged 66% since 2016
Maintain the sea lamprey wounding rate in fall gill netting at <2 A1 wounds per 100 lake trout >433mm total length	Met	Target has been consistently met since 1996 although there was a period of high A2 wounding rates between 1995 to 2004 (Fig. 8.5.6).
Maintain annual harvest to <5,000 fish in Canadian waters	Met	Not assessed annually or across the entire distribution
Emphasize strains that show the best combination of low post-stocking, juvenile, and adult mortality	Not assessed	In the absence of CWT in stocked lake trout, genetic analysis of all fish would be required in order to determine whether this target is being met. Currently only unclipped fish have tissue collect for genetic analysis.
Emphasize strains that are successfully producing a measurable level of wild recruits	Not reported	DNA samples from unclipped fish are routinely sent for analysis but are not reported here.
Protect naturally produced fish	Unclear	No special measures in place to meet this objective although harvest of all Lake Trout is generally low in Ontario

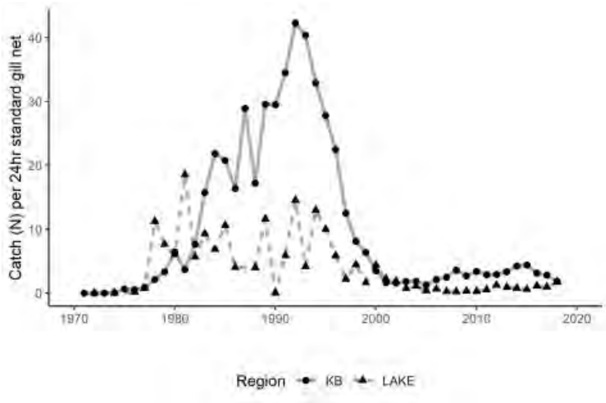


FIG. 8.5.1. Relative abundance of Lake Trout captured in the Ontario waters of Lake Ontario from Fish Community Index Gill Netting (Section 1.1) sites meeting the criteria identified within the plan tracked with the main basin of Lake Ontario ("LAKE"; indicated by triangles and dashed line) and with the Kingston Basin ("KB", indicated by circles and solid line).

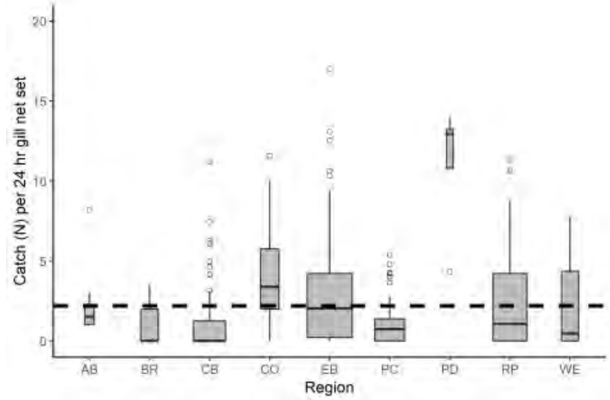


FIG 8.5.3. Relative abundance of Lake Trout captured in the Ontario waters of Lake Ontario in 2018 from Fish Community Index Gill Netting (Section 1.2) nets in the main basin fishing in water temperatures 15°C or colder of by geographic region (geographic region indicated in Fig. 8.5.2). Dashed line indicates global average across all sites. Box widths are scaled to the relative number of gill nets fish at a site. Boxes encompass 50% of the observations (25th to 75[th] percentile) with the median catch indicated by the solid line. Whiskers indicate 1.5 * the interquartile range and values beyond that range are plotted individually as open circles.

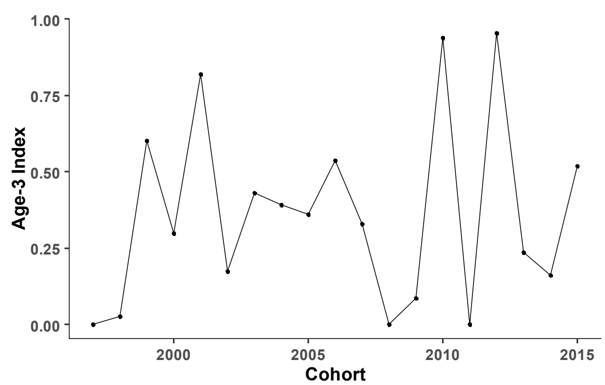


FIG. 8.5.4. Catch per unit effort (CUE) of age-3 Lake Trout standardized to 500,000 stocked captured in Fish Community Index Gill Netting (Section 1.1). The Lake Trout Management Strategy target has established a target CUE = 1.5.

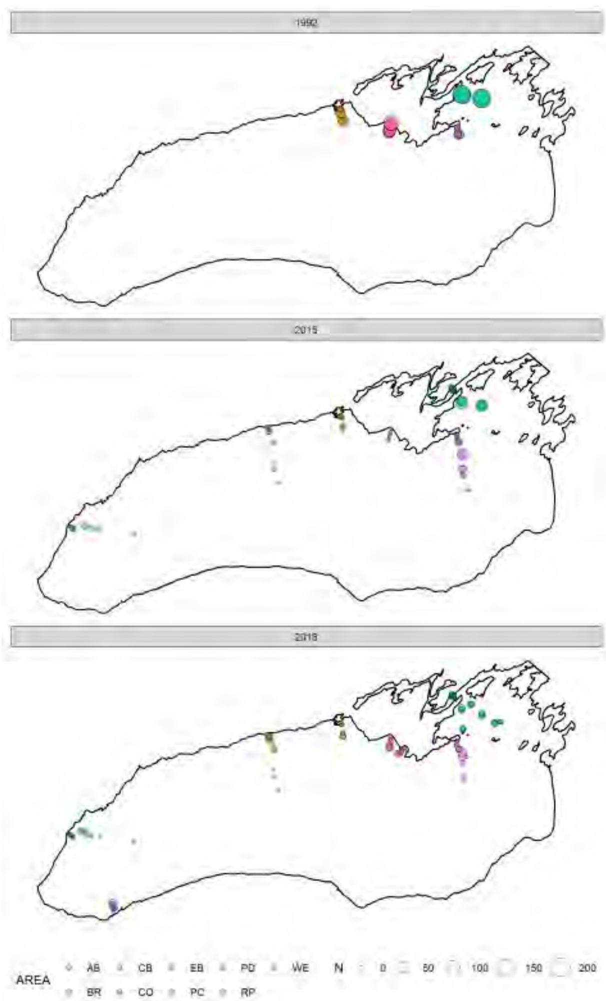


FIG. 8.5.2. Main lake gill netting in the Fish Community Index Gill Netting (Section 1.1) has increased in recent years covering a broader geographical area and range of depths. Points are scaled to Lake Trout catch (N) per 24-hour standard gill net set where the temperature at the net was 15°C or colder.

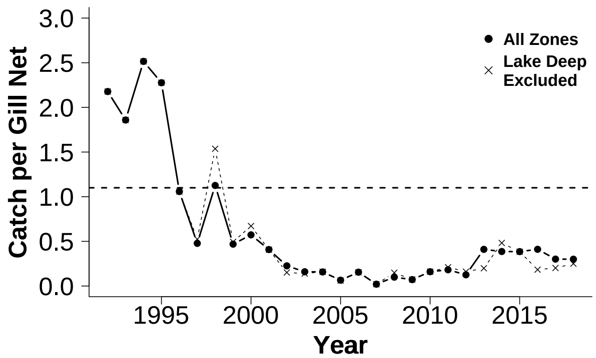


FIG. 8.5.5. Relative abundance of mature female Lake Trout greater than 4000 g captured in Fish Community Index Gill Netting (Section 1.1). Trend is present with and without Lake Deep sites as they were not conducted in all years.

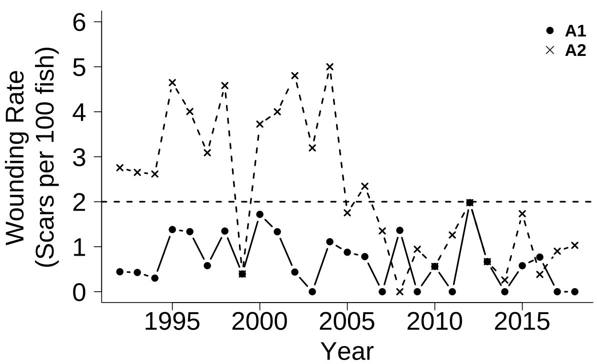


FIG. 8.5.6. Sea Lamprey scarring rate on Lake Trout captured in Fish Community Index Gill Netting (Section 1.1). Dotted line indicates the Lake Trout Management Strategy target of a maximum of two A1 wounds (fresh with no healing) per 100 Lake Trout

8.6 Hamilton Harbour Walleye Reintroduction

E. Brown and J. A. Hoyle, Lake Ontario Management Unit
J. Midwood, Fisheries and Oceans Canada, CCIW, Burlington

Past Restoration Efforts

Walleye declined in Hamilton Harbour in the early 1900s and were not observed in various fish surveys conducted during the mid-1900s. Walleye were reintroduced in Hamilton Harbour through adult transfer and spring fingerling stocking of Bay of Quinte strain in the 1990s (Table 8.6.1). This initial stocking effort was part of the local Remedial Action Plan objective to increase top predators in the Hamilton Harbour fish community. All Walleye subsequently caught in trap net assessments during 2006 and 2008 had DNA showing Bay of Quinte origin, consistent with the 1990s stocking and adult transfer programs. Walleye abundance declined and disappeared from the trap net surveys between 2006 and 2012 (Fig. 8.6.1).

Current Restoration Efforts

MNRF reinitiated Walleye stocking in 2012. In 2012; 100,000 summer fingerlings stocked in July and 74 adult Walleye (approximately 10-years-old hatchery brood stock) were stocked in November. In 2013, 10,000 July summer fingerlings were stocked, and in 2014, 950,000 day-old swim-up fry were stocked in June. In 2015, over one million swim-up fry and nearly 53,000 summer fingerlings were stocked in May and July, respectively (Table 8.6.1). In 2016, 168,000 1-month old fry were stocked in the spring and 115,722 summer fingerlings were stocked on June 30. In 2018, 1,000,000 swim-up fry were stocked in the spring, followed by over 82,176 fingerlings stocked in July. Results of the 2012 summer fingerling Walleye stocking event continue to be very successful, with subsequent stocking events less so to date. Moving forward, MNRFs stocking approach will be to stock approximately 100,000 summer fingerlings every other year.

TABLE 8.6.1. Walleye stocked into Hamilton Harbour, 1993-2018.

Year	Month	Life-Stage	Mean Weight (g)	Number of Fish	Source
1993	Oct	Adult	600	185	Transferred from Bay of Quinte
1994	Oct	Adult	1,500	129	Transferred from Bay of Quinte
1997	Oct	Adult	900	130	Transferred from Bay of Quinte
1998	Sept	Adult	1,364	120	Transferred from Bay of Quinte
1999	July	3-months	0.5	6,000	White Lake FCS (Bay of Quinte strain)
2012	July	3-months	0.4	100,000	White Lake FCS (Bay of Quinte strain)
2012	Nov	Adult	1,050	74	White Lake FCS (Bay of Quinte strain)
2013	July	3-months	0.5	10,000	White Lake FCS (Bay of Quinte strain)
2014	June	Swim-up Fry	n/a	950,000	White Lake FCS (Bay of Quinte strain)
2015	May	Swim-up Fry	n/a	1,017,625	White Lake FCS (Bay of Quinte strain)
2015	July	3-months	0.3	52,963	White Lake FCS (Bay of Quinte strain)
2016	May	Swim-up Fry	n/a	168,000	White Lake FCS (Bay of Quinte strain)
2016	June	3-months	0.5	115,722	White Lake FCS (Bay of Quinte strain)
2018	May	Swim-up Fry	n/a	1,000,000	White Lake FCS (Bay of Quinte strain)
2018	July	3-months	0.6	82,176	White Lake FCS (Bay of Quinte strain)

Monitoring and Assessment

Nearshore Fish Community Index Trap Netting (NSCIN)

NSCIN was conducted on Hamilton Harbour in August 2018 (see Section 1.3). A mean catch of 1.8 Walleye per trap net was observed (Fig. 8.6.1). This is just below the restoration target of 2 fish per net established prior to commencement of the 2012 Walleye stocking initiative. Though below the target, the mean catch of 1.8 fish per net is comparable to that of other Lake Ontario and St. Lawrence River nearshore areas (see Section 1.3). Fourteen of the 24 trap net lifts in Hamilton Harbour caught at least one Walleye (Fig. 8.6.2). Walleye were captured throughout Hamilton Harbour where suitable trap net sampling locations were located. Largest catch occurred at a trap net in the east end of the harbour (n=14).

Age was interpreted (otoliths) for a random sample of 24 of the 44 Walleye caught. These 24 fish ranged in length from 374 to 661 mm fork length (Fig. 8.6.3). Eleven were age-6 (mean fork length: 588 mm) and ten were age-2 (mean fork length: 410 mm). These fish were likely from the 2012 and 2016 stocking events, respectively. Two Walleye were age-3 and one was age-7. Results of the 2012 Walleye stocking continue to be very successful.

Seventeen of 18 males and all six female Walleye sampled were judged to be mature and capable of spawning in spring of 2019.

Spawning Assessment

In late-March 2018, Fisheries and Oceans Canada (DFO) deployed a 2-D acoustic telemetry positioning system over an area of Hamilton Harbour where spawning Walleye were detected in spring 2016 and 2017. As part of the Hamilton Harbour acoustic telemetry project, 43 walleye have been tagged and 15 of these individuals were detected on the 2-D array during the spawning season; one additional Walleye that was originally tagged in Toronto Harbour was also detected (Fig. 8.6.4). Results highlight areas within the 2-D array where Walleye congregate and this information will be used to guide an assessment of spawning success (i.e., egg deposition and larval recruitment) planned for spring 2019.

Concluding Remarks

An adequate level of top fish predators, such as Walleye, helps to achieve a balanced trophic structure in the fish community, and also complements local remedial actions to improve water quality and restore fish habitat in Hamilton Harbour.

All indications to date are that the 2012 Walleye stocking effort in Hamilton Harbour was highly successful in terms of survival and growth rates. 2018 was the first year Walleye from 2016

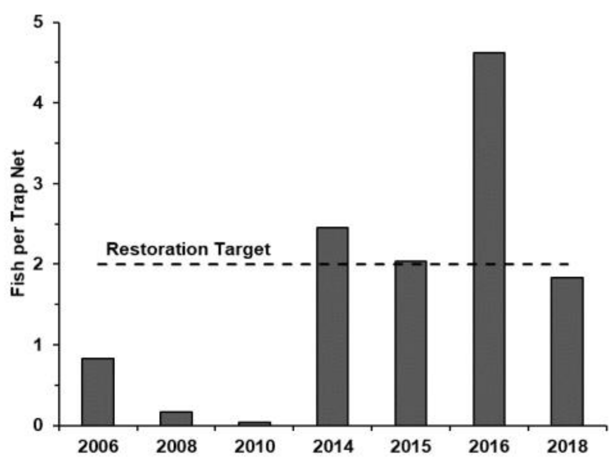


FIG. 8.6.1. Walleye catch (number of fish per trap net lift) on Hamilton Harbour, 2006-2018 (years indicated).

FIG. 8.6.2. Map of Hamilton Harbour showing the number of Walleye caught, in August 2018, at each trap net location. A total of 44 Walleye were captured.

stocking efforts were likely to recruit into the trap net gear. Though lower in abundance when compared to 2014 (i.e. the first 2012 detections), observations of the 2016 stocking event suggests a positive outlook for this year class. These year classes will be continued to be monitored in future trap net surveys.

An ongoing plan is in place to monitor contaminant levels for the Hamilton Harbour Walleye. To help further evaluate stocking success, local anglers are encouraged to report of any Walleye caught in Hamilton Harbour to LOMU. Of particular interest, moving forward, are the distribution and migration patterns as well as any spawning behaviour exhibited by these stocked Walleye.

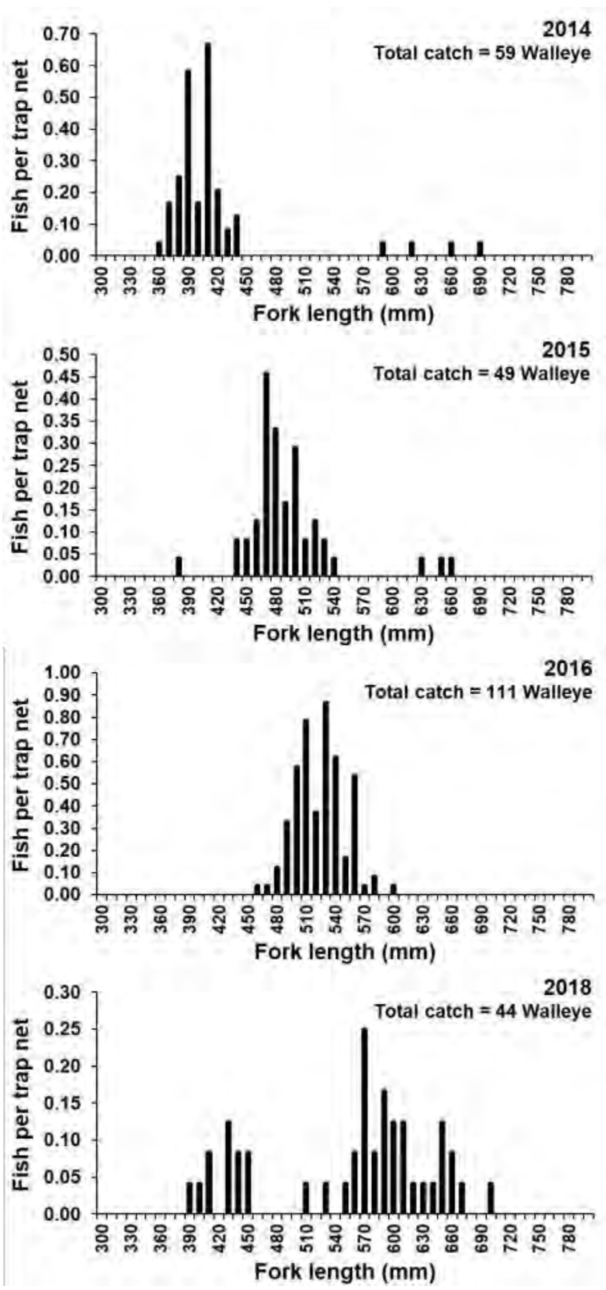


FIG. 8.6.3. Size distribution of Walleye caught during NSCIN trap net surveys conducted in Hamilton Harbour in August 2014, 2015, 2016 and 2018. Total catch of Walleye are indicated for each year.

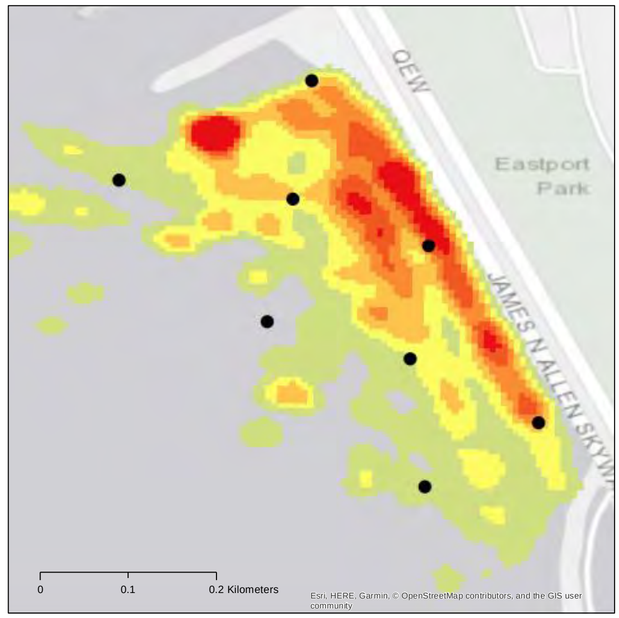


FIG. 8.6.4. Density plot of areas within the 2-D acoustic telemetry positioning array where tagged Walleye were found to congregate. Warmer colours indicate areas where more detections of Walleye occurred. The black dots represent the location of the acoustic telemetry receivers that define the 2-D arrays extent.

8.7 Lake Sturgeon

C. Lake, Lake Ontario Management Unit

Lake Sturgeon (*Acipenser fulvescens*) were a key component of the fish community in Lake Ontario and the Upper St. Lawrence river in the past but are now listed as endangered under the Endangered Species Act (ESA) in this area. Lake Sturgeon are identified in Lake Ontario's Fish Community Objectives (FCOs), with long-term goals of re-establishing populations in historical spawning locations such as the Napanee, Salmon and Trent Rivers (Lake Ontario FCO 1.2).

In order to achieve the goals set out in the FCOs for Lake Sturgeon, more information is needed related to their current distribution and abundance. Over two weeks during the spring of 2018, Lake Sturgeon were targeted with various gears in the Lower Trent River. The main goal of the project is to determine presence of Lake Sturgeon in the system, and if possible, implant an acoustic tag into captured Sturgeon to determine range and timing of movement in the Bay of Quinte and Lake Ontario Acoustic tags deployed in the program take advantage of other large-scale acoustic tracking programs being conducted throughout the Bay of Quinte and Eastern Lake Ontario (see Section 9.16 and 9.17).

The 2018 Lake Sturgeon survey took place in the Trent River, downstream of Lock 1 to the mouth of the Bay of Quinte from April 23 to May 14. Survey gear included baited hook lines and boat electrofishing. Gillnets were not used in 2018, however effort with the other gears was increased (Tables 8.7.1 and 8.7.2). Despite the increased effort, the baited hook lines did not capture any Lake Sturgeon (or any other fish species). The continued use of this gear in future surveys will be discussed by staff. During the time of the survey, 2018 had the lowest average temperature of the three years surveyed, which may have affected Lake Sturgeon distribution.

Acoustic Telemetry

A portable hydrophone was deployed daily during the 2018 spring survey and the Lake Sturgeon previously tagged (Vemco V16, 69 kHz; May 4, 2017) was detected consistently in the Lower Trent River, but did not appear to move upstream very far from the river mouth. This fish was also detected by several stationary receivers in the Bay of Quinte array (Fig. 8.7.1). A total of 9,694 detections of this fish were made on Bay of Quinte receivers (TNT, TNN and MPT) between October 2017 and October 2018. This fish has not been detected by the Telegraph Narrows receivers (TGN) in the east or at the Murray Canal receiver (MCL) to the west. Based on these observations, it appears that this fish did not leave the upper Bay of Quinte since being tagged in 2017.

Juvenile Lake Sturgeon Survival Study

The Lake Ontario Management Unit (LOMU), in partnership with the Springside

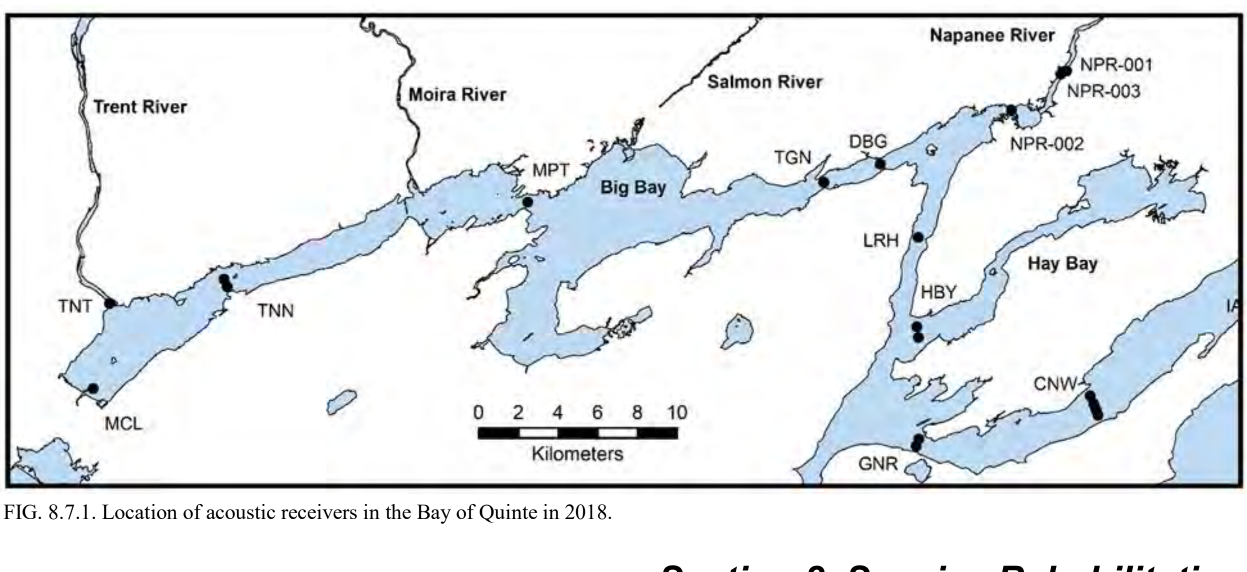


FIG. 8.7.1. Location of acoustic receivers in the Bay of Quinte in 2018.

Community Hatchery (operated by the Napanee and District Rod & Gun Club), released 21 juvenile Lake Sturgeon into the Napanee River on August 15, 2017. The fish were 3 years old and approximately 30 cm long. All fish were PIT-tagged; five also had acoustic tags implanted internally (Vemco V7, 69 kHz). Students from the Mohawks of the Bay of Quinte Community Well Being Day Camp participated, releasing individual fish from small buckets into the Napanee River. Three more juvenile Lake Sturgeon were released on September 8, 2017. These fish had received internal acoustic tags later than the ones released initially and required the extra time to recover prior to release.

In May 2018, ten PIT-tagged Lake Sturgeon were released. This brought the total number of Lake Sturgeon released to 34 (26 PIT-tagged only; 8 with an internal acoustic tag plus PIT tag). Only three Lake Sturgeon remain to be released (PIT-tagged only), and it is expected that this will occur in the spring of 2019.

Data collected from the acoustically tagged sturgeon were uploaded to the Great Lakes Acoustic Telemetry Observation System (GLATOS), allowing the overwinter movement of these fish to be tracked in the river Napanee (Table 8.7.3).

Of the eight acoustically-tagged Lake Sturgeon, six were detected in the Napanee River receiver array (NPR-1, NPR-2, NPR-3). Of these six individuals, five remained within the Napanee River for the entire duration of the tag's lifespan (earliest detection March 27, 2018; latest detection August 27, 2018). One fish, part of the early release, moved beyond the Napanee River and moved west as far as Massassauga Point (MPT; see Fig. 8.7.1). The average length of time that the six Lake Sturgeon were detected by the deployed receivers was 372 ± 16 days. The expected battery life of the acoustic tags used is 376 days, so the tagged Lake Sturgeon will not be detected in the receiver array in 2019.

Overall, the juvenile tagged Lake Sturgeon showed good survival, and did not venture far from the Napanee River during the first year of their release. A more detailed analysis of Lake Sturgeon movement will be reported on in a separate report.

TABLE 8.7.1. Baited hook line summary data (including temperature) for the Trent River Lake Sturgeon survey.

Year	Dates	Sets	Mean Set Time (hours)	Total Set Time (hours)	Avg. Depth (m)	Temperature (°C)
2016	May 16 - May 26	22	22.86 ± 1.5	502.8	-	15.3 ± 3.4
2017	April 25 - May 4	18	22.9 ± 0.58	413.9	2.4 ± 1.2	10.9 ± 0.5
2018	April 23 - May 2	30	23.9 ± 0.52	717.9	5.4 ± 0.61	7.5 ± 1.3

TABLE 8.7.2. Boat electrofishing summary data for the Trent River Lake Sturgeon survey.

Year	Dates	Sample Days	Mean Shock Time per Sample Day (minutes)	Total Shock Time (minutes)
2016	May 16 - May 26	6	27.5 ± 14.8	165
2017	April 25 - May 4	8	27.7 ± 9.6	222
2018	April 23 - May 14	8	65.7 ± 25.2	526

TABLE 8.7.3. Summary of acoustic tagging data for juvenile Lake Sturgeon released in the Napanee River

Tag_ID	Tagging Date	Number of Detections	First Detection	Last Detection	Detection Timespan (days)	Detection Locations	Tag Activation to Last Detection (days)
1284	Aug 11, 2017	237	Nov 07, 2017	Jul 18, 2018	253	DBG MPT TGN	341
1281	Jun 28, 2017	6,092	Mar 27, 2018	Jul 14, 2018	109	NPR	382
1282	Aug 11, 2017	24,768	Mar 27, 2018	Aug 27, 2018	153	NPR	381
1283	Aug 11, 2017	11,416	Apr 06, 2018	Aug 16, 2018	132	NPR	371
1280	May 30, 2017	1,758	May 11, 2018	Jun 14, 2018	34	NPR	381
1285	Aug 08, 2017	42	Jul 16, 2018	Aug 17, 2018	32	NPR	374

9. Research Activities

9.1 Pop-off data storage tags reveal vertical and thermal behaviours in Lake Ontario salmon and trout

Project Leads: Graham Raby and Aaron Fisk (University of Windsor, Great Lakes Institute of Environmental Research); Tim Johnson (OMNRF, Aquatic Research and Monitoring Section)

Lake Ontario contains a variety of native and non-native salmon and trout species that collectively support a vibrant recreational fishery. Each species fills a role ('niche') within the ecosystem and can provide a unique fishing experience. Current efforts to restore naturally-reproducing populations of the lake's native top-predators, Atlantic Salmon (*Salmo salar*) and Lake Trout (*Salvelinus namaycush*), if successful, will further diversify the lake's food web, which would help make the ecosystem more resilient in the long -term and add further fishing opportunities. Fishery managers can benefit from knowing the behaviours and habitat preferences of different species to inform their decision-making around how many fish are stocked into the lake and how to design surveys to assess abundance of each species. However, very few detailed data on fish behaviour in Lake Ontario are available because of the inherent difficulties in studying the behaviour of wild fish in such a vast lake.

Fortunately, new technological developments are changing that, particularly with the many types of electronic transmitters and data loggers that can be used to track individual fish in the wild. In this study, we used pop-off data storage tags to study the depths and temperatures used by different salmon and trout in Lake Ontario. Eighty-eight (88) of these bright-orange external loggers were attached to salmon and trout between 2014 and 2016. The loggers were programmed to record depth and temperature of the fish every minute for a full year before releasing from the fish (popping-off) and floating to the surface. In total, 31 of the 88 tags have now been found and returned to us (in exchange for a $100 reward) by members of the public who have found them on shore or caught fish with tags still attached. The lion's share of the tags we recovered were from Lake Trout and Chinook Salmon (*Oncorhynchus tshawytscha*) (11 and 13 tags retrieved, respectively). In total, we ended up with 9.1 million observations of depth and temperature from those fish and chose to focus our initial analyses on summer when we had the most complete data records for the greatest number of individual Lake Trout and Chinook Salmon. Collectively, the data show that the temperature envelope in which Lake Trout spent the majority of their time (in summer) was 4-10 °C, while Chinook Salmon spent most of their time in waters 10-18 °C. There was also vertical separation, but

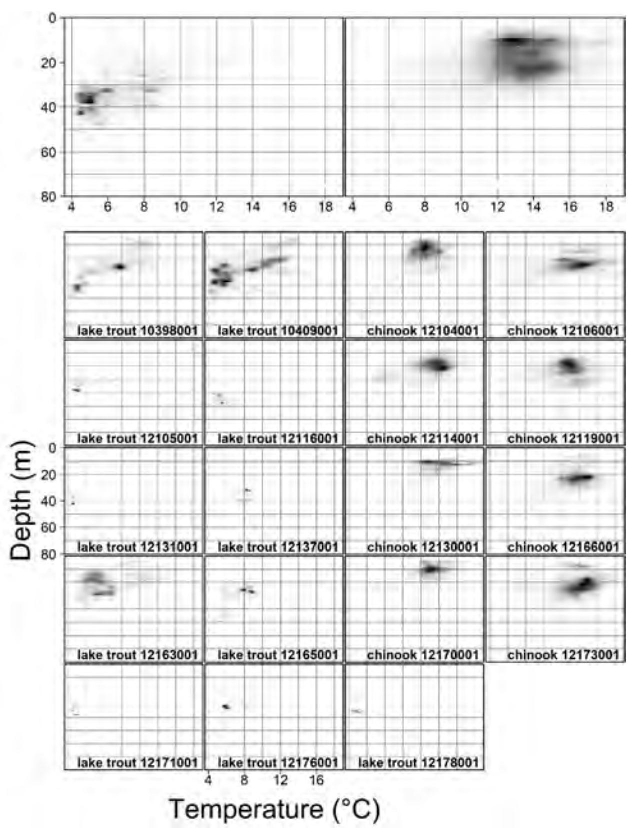


FIG. 9.1.1. "Home range" KUDs for individual Lake Trout (*S. namaycush*) and Chinook Salmon (*O. tshawytscha*) showing their distribution by depth (vertical axis) and temperature (horizontal axis) during the summer months (Jun 21 through Sept 1) in Lake Ontario. Note that the core use area from these plots were very small for some Lake Trout because their depth and temperature varied so little throughout summer. The plots were made using the 'kde2d' function in the R package 'MASS' (Venables & Ripley 2002).

with some overlap: Chinook Salmon mostly were typically 5-35 m below the surface, while Lake Trout were deeper, mostly occupying waters in the 20-60 m range (Fig. 9.1.1).

In general Chinook Salmon were more active vertically, with extensive vertical movements occurring during day and night relative to most of the Lake Trout we examined (Fig. 9.1.2). At the same time, in most parameters we looked at, there was more variation/diversity among Lake Trout (i.e., fish-to-fish differences) in depth and temperature, whereas all Chinook Salmon exhibited similar behaviours and habitat preferences (Fig. 9.1.1). Those differences between the species reflect other aspects of their biology, particularly feeding: Chinook Salmon are pelagic predators, and in Lake Ontario feed almost entirely on alewife in the water column. Lake Trout, on the other hand, are known to be very flexible in their diet: in the case of Lake Ontario it appears that some fish focus on feeding on bottom -oriented prey species whereas others spend time venturing into warmer surface waters to chase other prey like alewife.

An interesting discovery from these data was that there was a crepuscular pattern in vertical activity for Chinook Salmon (Fig. 9.1.2). Said a different way, Chinook salmon tended to make multiple deep dives around sunrise and sunset, which cause them to, on average, occupy deeper and colder waters during those times than at other times during the 24-hour clock. Further research will be required to clarify what was driving that behaviour; we can only speculate that it represents a feeding tactic driven by alewife behaviour during these periods (dawn and dusk).

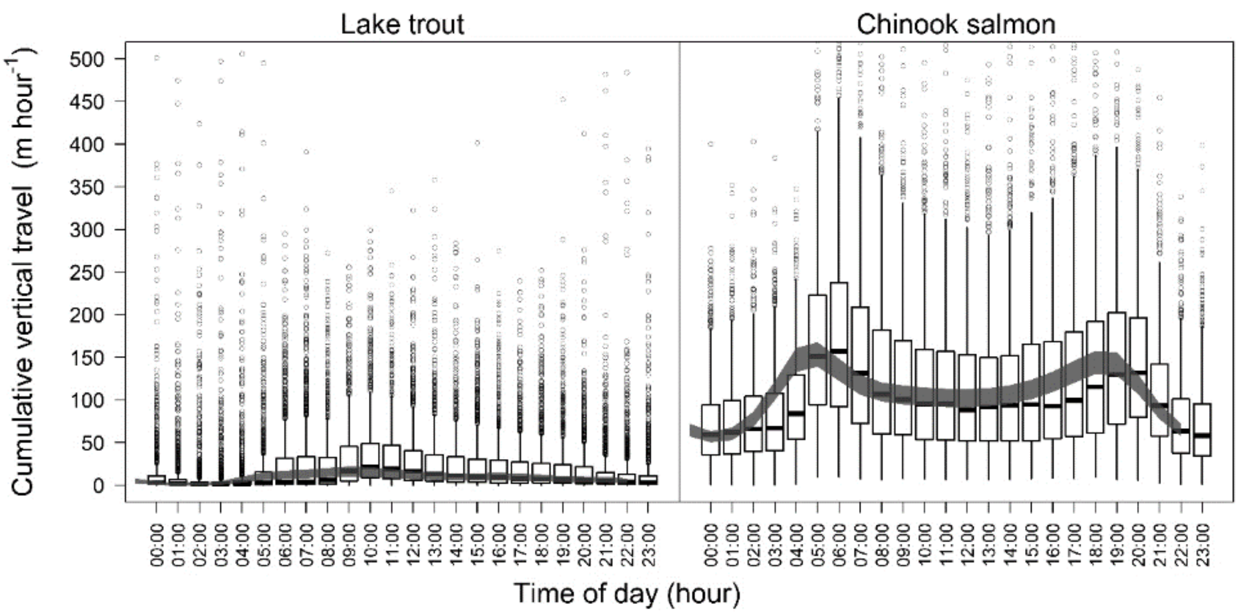


FIG. 9.1.2. Average hourly change in depth per hour for Lake Trout (*S. namaycush*; n=11) and Chinook Salmon (*O. tshawytscha*; n=8) during the summer (June 21 through Sept 1) in Lake Ontario. Translucent grey areas represent mean ± 95% confidence intervals derived from separate generalized additive mixed models while boxplots (background) represent all the data for both species.

9.2 Informing Lake Trout restoration in Lake Ontario based on interactions with other top predators in time and space

Project Leads: Silviya Ivanova and Aaron Fisk (University of Windsor, Great Lakes Institute for Environmental Research); Tim Johnson and Brent Metcalfe (OMNRF, Aquatic Research and Monitoring Section)
Partners: Jana Lantry and Michael Connerton (New York State Department of Environmental Conservation)

Evidence from diets suggests trout and salmon show considerable overlap with respect to food preference. However, we do not know the degree to which spatial and temporal interactions are driving this dietary overlap. Knowing how much species interact, and potentially compete for shared resources, would better inform management planning with respect to restoration plans and stocking strategies. Lake Ontario is home to six salmonid species attracting recreational anglers from across North America. Currently, several fish species, including Lake Trout (*Salvelinus namaycush*) and Chinook Salmon (*Oncorhynchus tshawytscha*) are being stocked in Lake Ontario in an effort to support economically important recreational fisheries, provide predatory control for largely non-native prey fishes, and promote restoration of historically important species. The Lake Ontario Lake Trout population was decimated in the 1900s due to sea lamprey, habitat loss and overfishing, and efforts to rehabilitate the population have been on-going for over 40 years. Chinook Salmon are the most sought–after species by anglers largely driving the open lake recreational and charter boat fishery. Understanding the spatial and temporal interactions of Lake Trout with other top predators such as Chinook Salmon is critical to understand the potential for restoration of Lake Trout in Lake Ontario and elsewhere.

Little is known of Lake Trout and Chinook Salmon seasonal movements and preferred depth and temperature in Lake Ontario. Acoustic telemetry provides a means to begin to understand these behaviours. We are using both fixed-station receiver arrays in the east and west ends of Lake Ontario, and an autonomous underwater vehicle (self-propelled mini-sub) to track the movements and behaviour of Lake Trout and Chinook Salmon that have been surgically implanted with acoustic tags. Both Lake Trout and Chinook Salmon have been tagged on an yearly basis since 2017.

As of May 2018, we collected enough data to examine Lake Trout behaviour and habitat preference in eastern Lake Ontario. Lake Trout prefer a cold-water environment and thus, we examined their spatial use based on lake thermal conditions – constant cold-water temperatures (winter), warming or cooling temperatures (spring and fall), and stratified (layered) temperatures ranging from warm at the surface to cold on the bottom (summer). Our results showed a preference for a more restricted deep-water residency in the summer months when water at shallower depths is too warm (Fig. 9.2.1c), and a more variable and broad distribution at other times of the year (Fig. 9.2.1 a, b, and d). In addition, these results show that even though Lake Trout habitat preference is modified based on lake water temperature conditions, they are very individual in their behaviour and movements. Based on this, our next steps are to determine whether there are common migration routes used by individuals, and if so, to determine their locations. Similar analyses will be undertaken for Chinook Salmon and results for the two species will be compared to assess the degree of overlap of their habitat use.

This work contributes directly to Lake Trout and Bloater (*Coregonus hoyi*) (to understand predator behaviour relative to bloater distribution) restoration, and thus to increasing biodiversity in Lake Ontario. On a broader scale, this research contributes new insights on the interactions of top predator fish in large lake ecosystems, which can inform predator-prey and bioenergetic models in support of more adaptive stocking strategies and management plans.

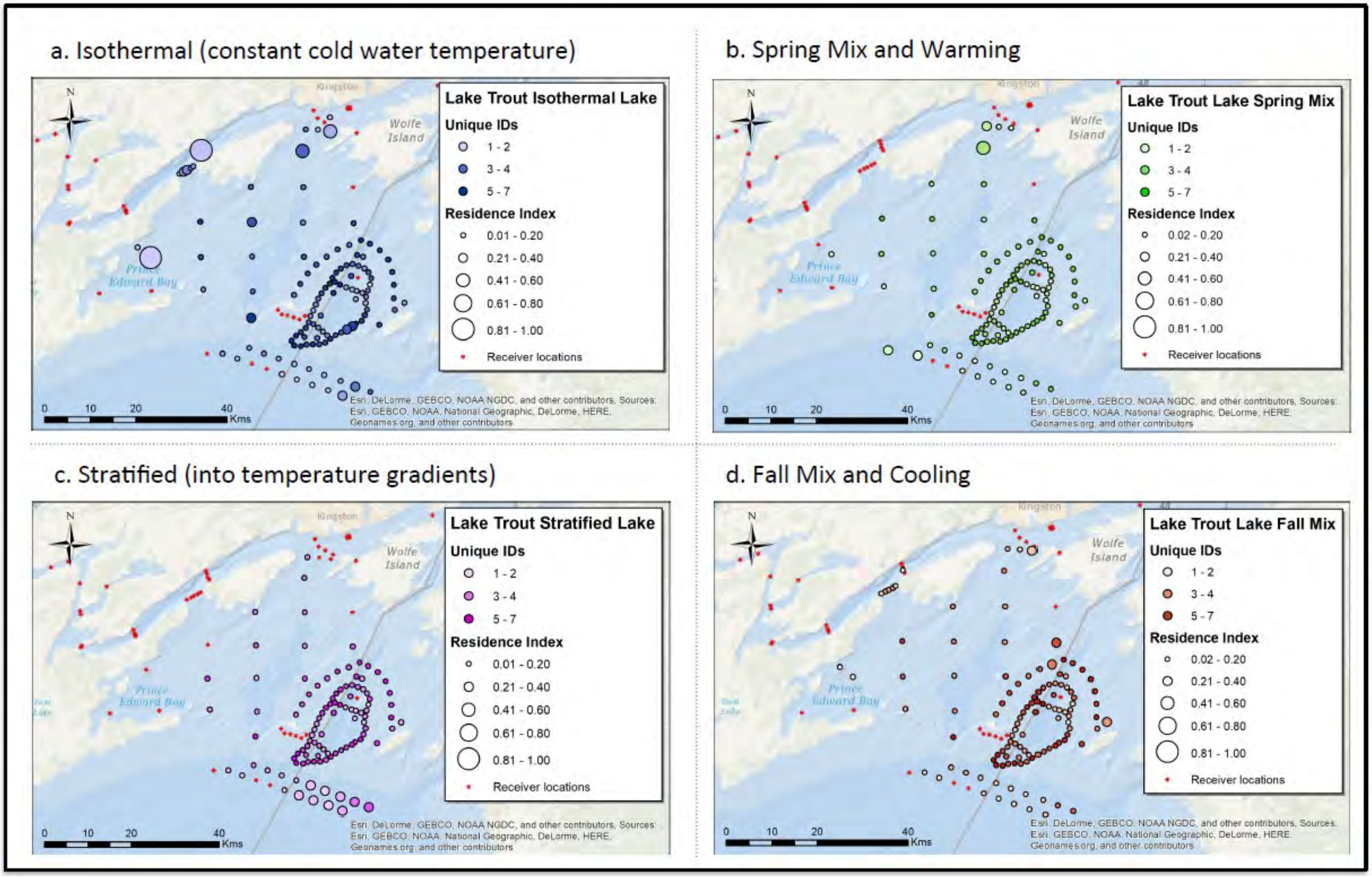


FIG. 9.2.1. Residency of Lake Trout in eastern Lake Ontario based on varying water thermal conditions: a) shows the time of the year when the lake water temperature are near constant below 5° C from top to bottom; b) shows the period when top layers of the lake are quickly warming up, but the bottom layers remain cold; c) shows the period when the lake temperatures reflect a relatively constant and warm upper layer, and a relatively constant and cold deeper layer; and d) shows the residency during the period when the lake's top and bottom layers begin mixing and overall water cooling occurs.

9.3 Wild vs. hatchery Atlantic Salmon smolt success in a Lake Ontario tributary

Project Leads: Sarah Larocque and Aaron Fisk (University of Windsor, Great Lakes Institute for Environmental Research); Tim Johnson (OMNRF, Aquatic Research and Monitoring Section)

Atlantic Salmon (*Salmo salar*) smolts are often stocked into rivers to supplement natural reproduction; however, hatchery-reared fish can have lower survival compared to their wild counterparts. Few studies have assessed migratory performance and survival differences in wild and hatchery smolts in rivers with barriers which may also impact survival. OMNRF has observed both wild and hatchery smolts moving through the Credit River system, a key tributary for Atlantic Salmon stocking in Lake Ontario (see Section 6.1). However, the overall survival and movement strategies (e.g., migratory speed, times of day, effects of environmental parameters on migration) for wild and hatchery smolts to complete the migration to Lake Ontario is unknown. Furthermore, the presence of low-head dams on the Credit River may further reduce survival of smolts.

Using acoustic telemetry, we assessed survival and migration patterns of wild (2017: n = 8; 2018: n = 30) and hatchery (2017: n = 32; 2018: n = 30) Atlantic Salmon smolts in the Credit River for two years (Fig. 9.3.1). Wild smolts were approximately 14 times more likely to survive than hatchery smolts, and smolts in 2017 were 5.5 times more likely to survive than in 2018. Using mark-recapture models, survival·km^{-1} was lowest at the release site (except for one location where mortality was non-typically high (Fig. 9.3.2)). Estimated survival·km^{-1} was nearly 100% thereafter, with no reduction in survival with downstream passage over the dams (Fig. 9.3.2). Both wild and hatchery fish migrated at similar speeds, and primarily at night further attributing increased hatchery mortality to stocking practices and not behavioural differences. Throughout the river, migration speed increased as fish moved downstream below the first dam (as the river entered urbanized areas) and decreased once reaching Lake Ontario. Predation events were not observed with the use of predation tags and two wild smolts were later detected 25 km southwest of the Credit River in Lake Ontario. Understanding factors influencing the survival of wild and hatchery smolts could help managers optimize stocking strategies to improve Atlantic Salmon reintroduction success.

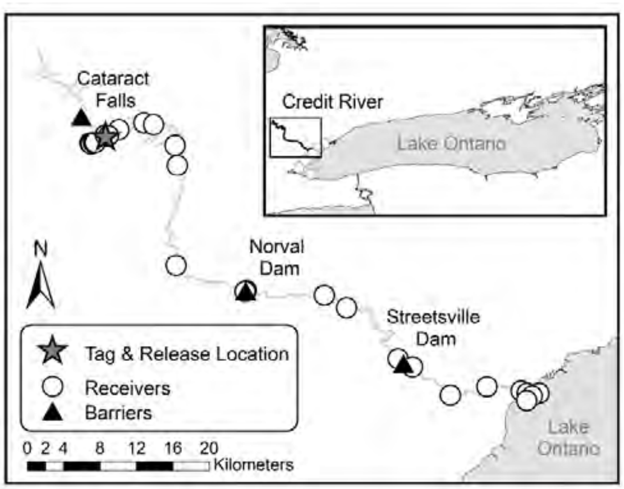


FIG. 9.3.1. Location of acoustic telemetry receivers, barriers (labelled), and general tag and release site on the Credit River, Ontario, as well as receivers in the western basin of Lake Ontario (see inset).

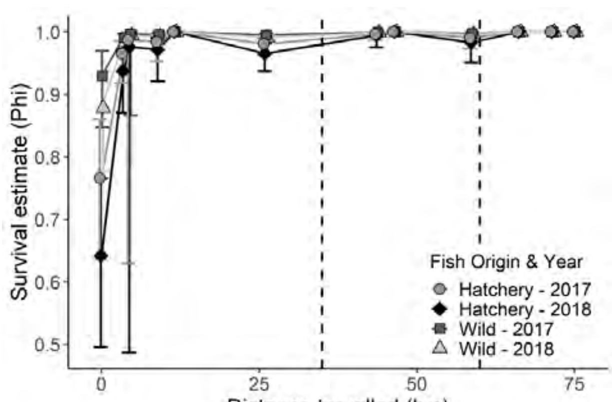


FIG. 9.3.2. Non-cumulative mean (and 95% CI) estimated survival·km^{-1} at receiver locations of acoustically tagged wild and hatchery Atlantic Salmon (*S. salar*) smolts in 2017 and 2018 as they migrated from the release point (km 0) in the Credit River to Lake Ontario (km 75). Location of dams are indicated by a dashed line.

9.4 Effects of surgically-implanted acoustic transmitters on juvenile salmonid performance

Project Leads: Graham Raby, Aaron Fisk, and Andrew Darcy (University of Windsor, Great Lakes Institute of Environmental Research); Tim Johnson (OMNRF, Aquatic Research and Monitoring Section)
Collaborators: OMNRF Fish Culture Section; Trevor Pitcher (University of Windsor, Freshwater Restoration Ecology Centre)

Acoustic telemetry is now commonly used by researchers to make fundamental discoveries about fish biology and, increasingly, to inform fisheries management. Many applications of telemetry rely on an assumption, often unsupported by data, that the methods they use will not affect the study animals in ways that could bias conclusions arising from the research. In this study, we investigated the effects of acoustic tag implantation on resting metabolic rate, swimming speed (U_{crit}), survival, and growth in juvenile Rainbow Trout (*Oncorhynchus mykiss*) and juvenile Lake Trout (*Salvelinus namaycush*). Acoustically-tagged fish were also tagged with tiny passive integrated transponders ('PIT tags') so that individuals could be tracked through time. Also, we included 'sham' (i.e., fish that received full surgery, including a PIT but no acoustic tag)

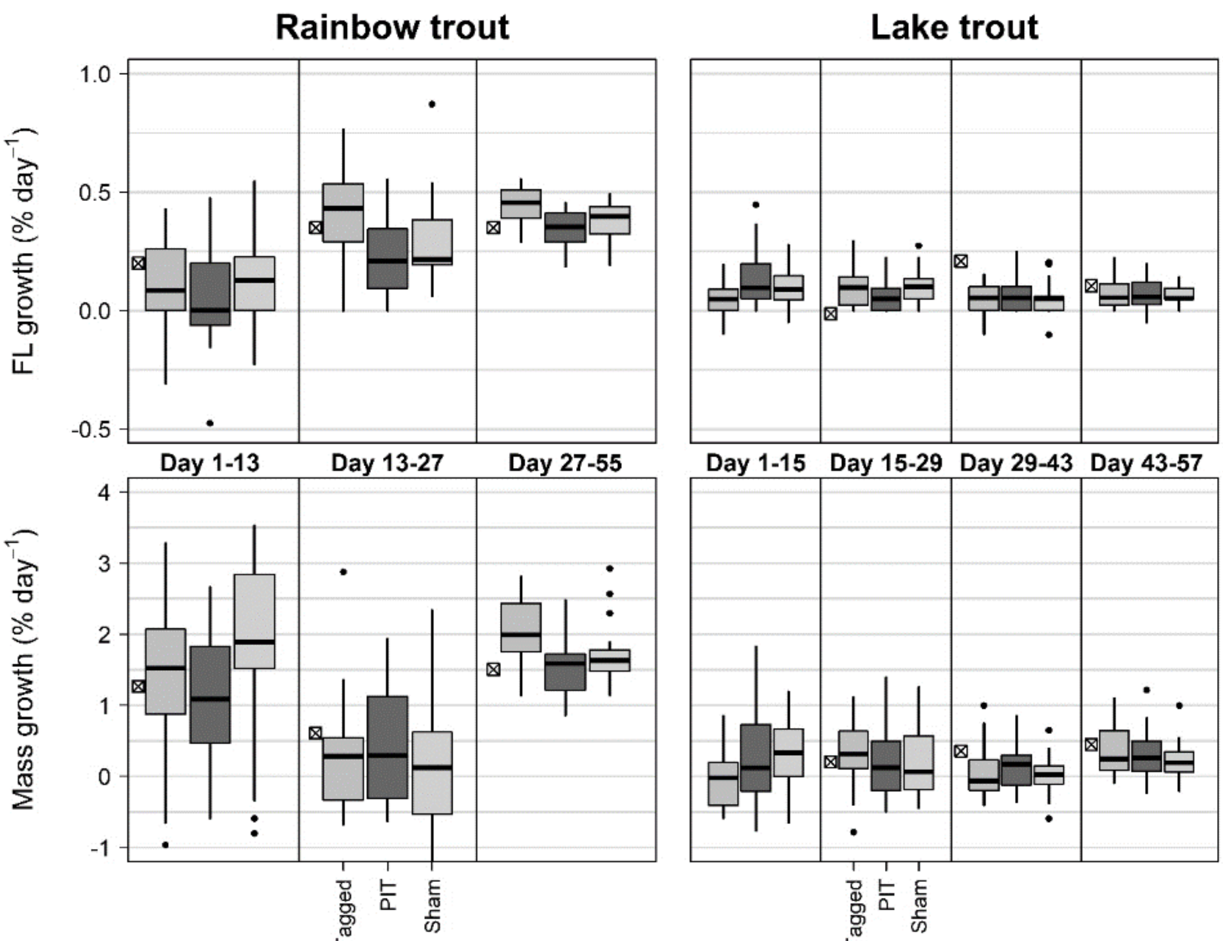


FIG. 9.4.1. Boxplots showing individual specific growth rates for our three treatments for which we could keep track of individuals – acoustically tagged ("tagged"), fish that were only PIT-tagged ("PIT"), and fish that had a "sham" surgery without implantation of a transmitter. Each plot also contains a hashed box symbol (left side of the panel) that indicates the overall group mean growth rate for fish in the control treatment (for which we could not keep track of individuals because they were completely untagged).

and 'PIT-only' groups, in addition to full controls (i.e., no surgery but fish otherwise handled the same). Survival was very high in all treatments during our two-month long experiments. Growth rates in tagged fish were equal to or greater than those in PIT-tagged and sham surgery fish. Among tagged fish, there were weak but significantly negative effects of tag burden (tag weight as a percent of fish mass) on growth: Rainbow Trout 2.7 ± 0.9 % (mean ± s.d.) and 4.2 ± 1.0 % for Lake Trout (range of 1 to 7.5 %) (Fig. 9.4.1). Tagged fish had marginally lower swimming performance compared to control fish, showing reductions of 8 ± 4% for Lake Trout and 5 ± 2 % for Rainbow Trout relative to full control fish (Fig. 9.4.2). Acoustic tags did not have clear effects on resting metabolic rate but there was an interaction whereby resting metabolic rate tended to increase with time since surgery in tagged Rainbow Trout but not in other treatments (the same trend did not occur in Lake Trout). Collectively, our findings suggest there were subtle, context-dependent effects of acoustic tagging in juvenile Lake Trout and Rainbow Trout during our eight-week laboratory experiment. This study provides important reassurance that for fish tagged with modest (<5%) tag burden, effects on growth and physiology are negligible, reinforcing the utility of acoustic telemetry technology to understand movement, behaviour, and survival of tagged fish, including juveniles commonly stocked by management agencies (see Section 6.1). Further research will be required to assess whether tagging can cause meaningful behavioural effects in these species in captivity or in the wild.

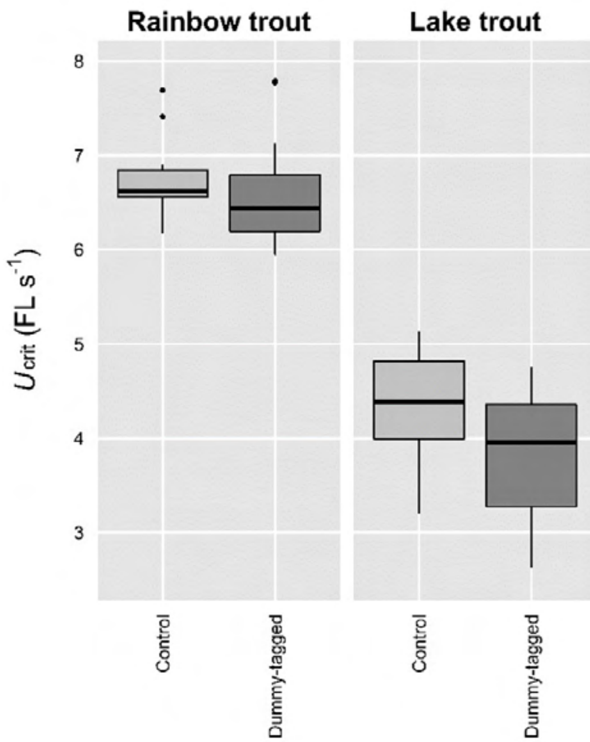


FIG. 9.4.2. Critical swimming speed (U_{crit}) (FL·s^{-1}) for Rainbow Trout (*O. mykiss*) and Lake Trout (*S. namaycush*) (control [n=11-15] and acoustic-tagged [n=15-16]) (+-SE). Mid-line (horizontal) of boxplot denotes the median (middle 50 %) value, the lower edge of the box corresponds to the first quartile, and the upper edge of the box corresponds to the third quartile. The middle 50% of the data distribution lies within the box, and the interquartile range (1.5 x) is represented by the upper and lower whiskers (or the most extreme value, depending on which is closer to the median).

9.5 Learning more about fish behaviour in Lake Ontario with enhanced acoustic telemetry technologies

Project Leads: Tim Johnson and Brent Metcalfe (OMNRF, Aquatic Research and Monitoring Section); Aaron Fisk (University of Windsor, Great Lakes Institute for Environmental Research)
Collaborators: Jon Midwood (Fisheries and Oceans Canada); Andy Todd (OMNRF, Lake Ontario Management Unit); Bill Sloan (OMNRF, Aquatic Research and Monitoring Section); Tim Drew (OMNRF, White Lake Fish Culture Station)

Improved understanding of temporal and spatial distribution of fishes in Lake Ontario could help refine our knowledge of fish resource use, energetic demands, or potential for competition with other species. This information could help optimize stocking strategies, harvest regulations, or species rehabilitation practises. The Aquatic Research and Monitoring Section at the Glenora Fisheries Station is learning more about fish distribution and behaviour, habitat use, and survival using acoustic telemetry technology (ultrasonic tags surgically implanted in fish detected by moored underwater listening devices). Currently, Lake Ontario researchers have listening arrays (a concentration of acoustic receivers) deployed at both the west and east ends of the lake (Fig. 9.5.1). These arrays have helped researchers observe long-distance movements in fish [e.g., walleye (*Sander vitreus*), salmonids], daily vertical movement behaviours [e.g., bloater (*Coregonus hoyi*)], and survival of stocked prey fish (e.g., bloater). In September 2018, we deployed an additional 29 acoustic receivers south of Point Petre (Prince Edward County). The 29 receivers are positioned in two parallel lines (to allow us to assess direction of fish movement) running SW from shore to a water depth greater than 100 metres. This array is our first attempt at listening for fish closer to the centre of the lake where few receivers currently exist. The addition of these receivers will allow us not only to detect fish moving from one end of the lake to the other, but also how and when those movements are made. Examining these interbasin movements in greater detail will reveal, for example, whether fish move along specific depth or temperature corridors, whether their movements are triggered by seasonal cues or other timing influences, and whether some fish make multiple interbasin migrations throughout the year.

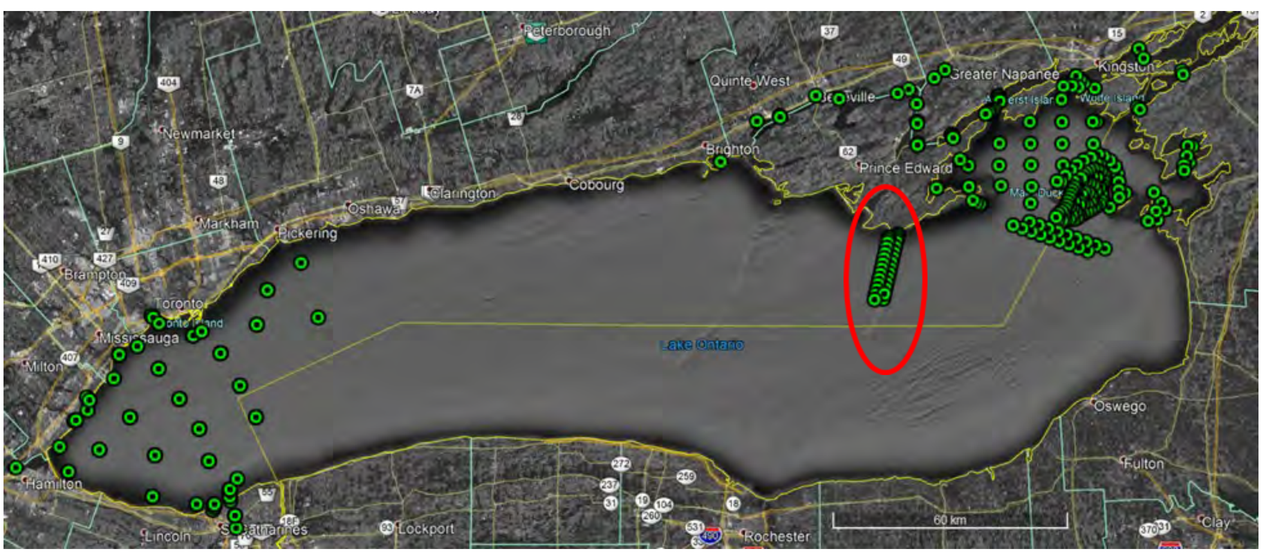


FIG. 9.5.1. New and existing acoustic receiver arrays in Lake Ontario (indicated by circle with black dot in centre). New receiver array deployed SW of Point Petre highlighted with oval line near centre of map. Map generated with Google Earth.

Also new in 2018 was the testing, and subsequent deployment, of acoustic tags that can determine when a predation event has occurred, i.e., when the initially tagged prey fish has been eaten by a predator fish. Prior to field use, we worked collaboratively with the manufacturer to test these novel tags under laboratory conditions to ensure the tags were able to correctly identify a predation event (with no false reporting). Once evaluations were completed, tags were implanted in 50 bloater and the fish were released into Lake Ontario in late November (as part of a larger stocking event). These new "predation tags" will allow researches to estimate the behaviour and fate of stocked prey fishes with accuracy and precision not previously available. As this technology is very new, this represents one of its first uses in a freshwater environment.

The high-quality behaviour, habitat-use, and survival information collected from these novel acoustic tags and enhanced arrays will help fishery managers better understand and manage fish populations in the Great Lakes. These undertakings support the OMNRF's ongoing commitment to generate new ecological knowledge to support fisheries management in Ontario.

9.6 Detection probability of acoustic transmitters in Lake Ontario: trends in spatial and temporal variability and the influence of environmental parameters

Project Leads: Natalie Klinard and Aaron Fisk (University of Windsor, Great Lakes Institute for Environmental Research); Tim Johnson (OMNRF, Aquatic Research and Monitoring Section)
Collaborators: Jordan Matley (University of Winsor, Great Lakes Institute for Environmental Research); Edmund Halfyard (Nova Scotia Salmon Association)

Acoustic telemetry is a valuable tool that is used to investigate the movement and behaviour of aquatic organisms and inform fisheries management and conservation strategies. Passive acoustic telemetry requires a tag that emits sound signals that are detected and recorded by receivers at fixed locations underwater. Tags are surgically implanted or externally attached to animals and then the animal is detected when it is within detection range of a receiver. Accurate interpretation of acoustic telemetry detection data relies on the knowledge of detection range and the assumption that the probability of detecting a tag remains relatively consistent throughout the study.

OMNRF and New York State Department of Environmental Conservation have developed an initiative to re-establish a self-sustaining population of deepwater ciscoes in Lake Ontario by stocking 500,000 juvenile hatchery-reared Bloater (*Coregonus hoyi*) annually. We are using acoustic telemetry to determine what happens to stocked bloater following their release into the lake. Simultaneously, we are conducting range testing in our receiver array to determine our ability to detect tagged bloater, how it changes through space and time, and how it is impacted by environmental conditions.

In October of 2015, we deployed 8 range tags that were a combination of three power output levels (V9-, V13-, and V16-69 kHz) at shallow and deep locations in Lake Ontario (Fig. 9.6.1). We used detection data from these tags from October 22, 2015 to May 23, 2016 to estimate the likelihood of tagged fish detection as a function of distance from the receiver, tag power output, and tag depth (Fig. 9.6.2). The lowest power output tags (V9) had the shortest detection ranges while the highest power output tags (V16) were detected at the greatest distance. Tags situated closer to the lake surface (in the *epilimnion*, the warmer upper layers of the lake) generally had shorter detection ranges than tags situated in deeper water (in the *hypolimnion*, the cooler deep layers of the lake) of the same power output (Fig. 9.6.2). Detection probability shows an overall decrease with increasing distance as the ability of sound to travel through water is reduced at greater distances.

In the coming year we expect to perform similar analyses on range tag data from 2017-2019 to examine trends in detection probability through all seasons in a year, as well as amongst years. We will evaluate the impact of environmental variables on detection probability both spatially and temporally. We will apply our findings to the detection data for tagged bloater that have been stocked in Lake Ontario since 2015 to more accurately determine fish locations and fish behaviour. The detection probability data will also inform other acoustic telemetry studies involving Lake Trout (*Salvelinus namaycush*) and Chinook Salmon (*Oncorhynchus tshawytscha*) (see section 9.2).

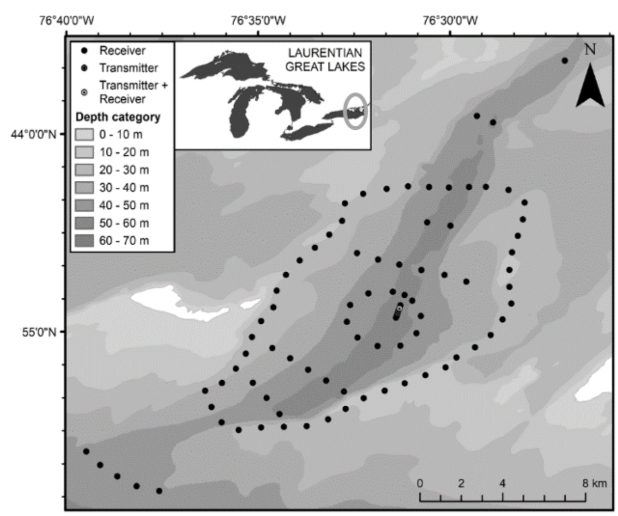


FIG. 9.6.1. Map illustrating the bathymetry and location of the receiver and transmitter moorings in northeastern Lake Ontario. Circle in map inset signifies location of study site within the Laurentian Great Lakes.

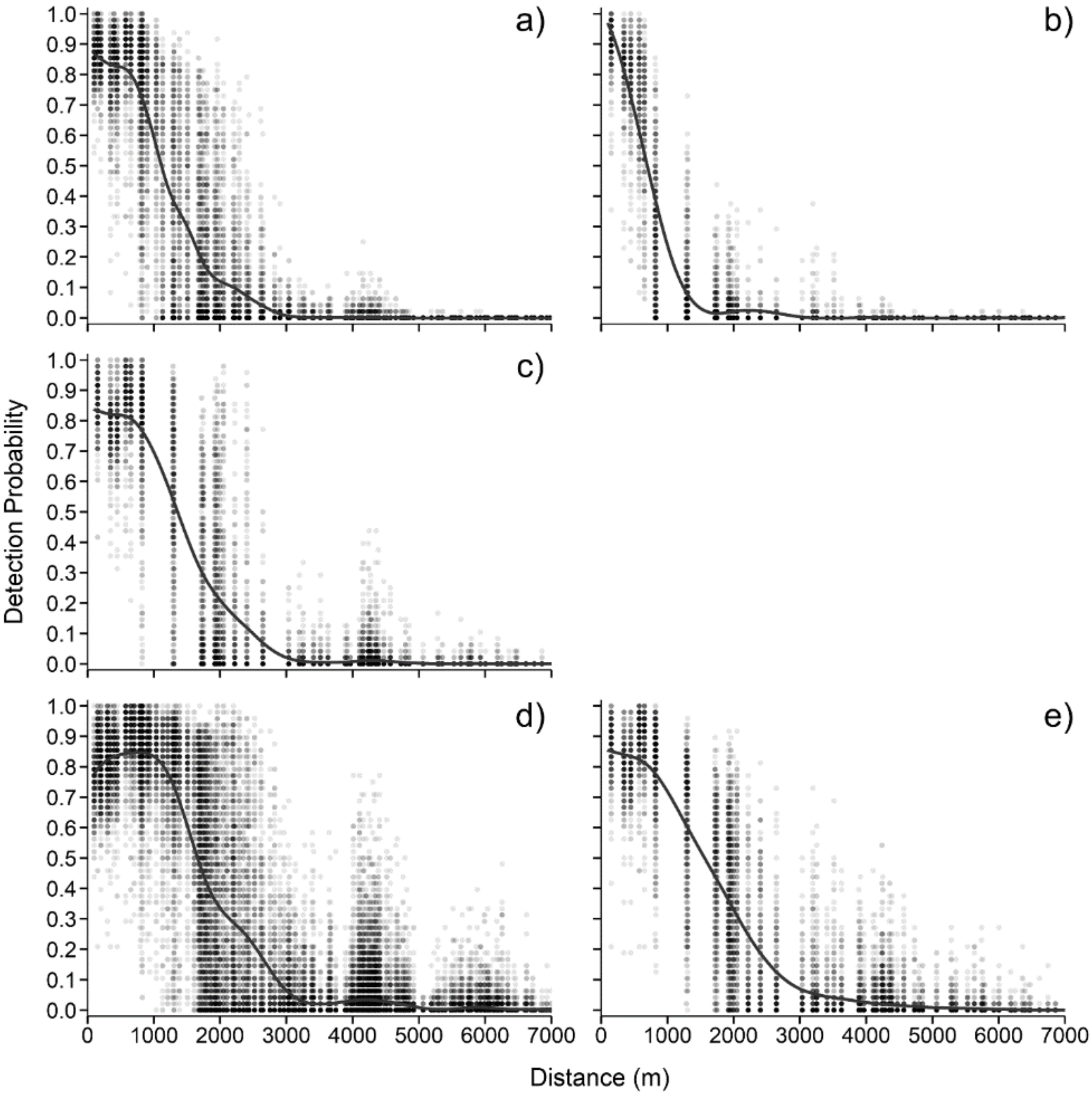


FIG. 9.6.2. Detection probability profiles estimated for the entire study period (22 October, 2015 to 23 May, 2016) by tag type and depth. Circles represent daily detection probabilities (0-1) and lines represent the overall spatial profile of detection probability for each transmitter category; (a) deep V9; (b) shallow V9; (c) deep V13; (d) deep V16; (e) shallow V16.

9.7 Station 81: Long-term monitoring at the base of Lake Ontario's food web

Project Leads: Mary Hanley and Tim Johnson (OMNRF, Aquatic Research and Monitoring Section)
Collaborators: Andy Todd (OMNRF, Lake Ontario Management Unit); Heather Niblock and Kelly Bowen (Fisheries and Oceans Canada)

To identify and respond to changes in the physical, chemical, and biological aspects of Lake Ontario, a long-term lower trophic level monitoring program has been maintained by the Aquatic Research and Monitoring Section (ARMS) at the Glenora Fisheries Station. From 1981-1995, Fisheries and Oceans Canada (DFO) collected limnological (e.g., temperature, transparency, water chemistry) and lower trophic level (e.g., plankton, benthos) samples to describe the conditions at Station 81 in eastern Lake Ontario (Fig. 9.7.1). In 2007 ARMS, in partnership with DFO and the Lake Ontario Management Unit, resumed sampling of Station 81 after an 11-year hiatus. In 2017 two additional sampling sites were added – T4L and NYSDEC (Fig. 9.7.1) – to understand spatial differences in lake conditions (to inform bloater restoration [see section 9.6]).

Station 81 is located near the centre of the Canadian waters of the eastern basin of Lake Ontario (44° 01.02'N, 76° 40.23'W; 34 m water depth), while the other two sites are located farther offshore. T4L is located west of the Duck-Galloo Ridge in 57m of water just outside of the eastern basin (43° 49.67'N, 76° 41.68'W). The NYSDEC site is located within the St. Lawrence Channel (43° 55.20'N, 76° 31.00'W; 53 m water depth) and has been infrequently sampled as part of an American biomonitoring program.

In 2018, samples were collected bi-weekly from May 7th to November 1st. Sample attributes included profiles of temperature, dissolved oxygen, and chlorophyll-a (an index of the amount of algae), Secchi depth (transparency), water samples for nutrient analysis, and samples describing the phytoplankton and zooplankton communities.

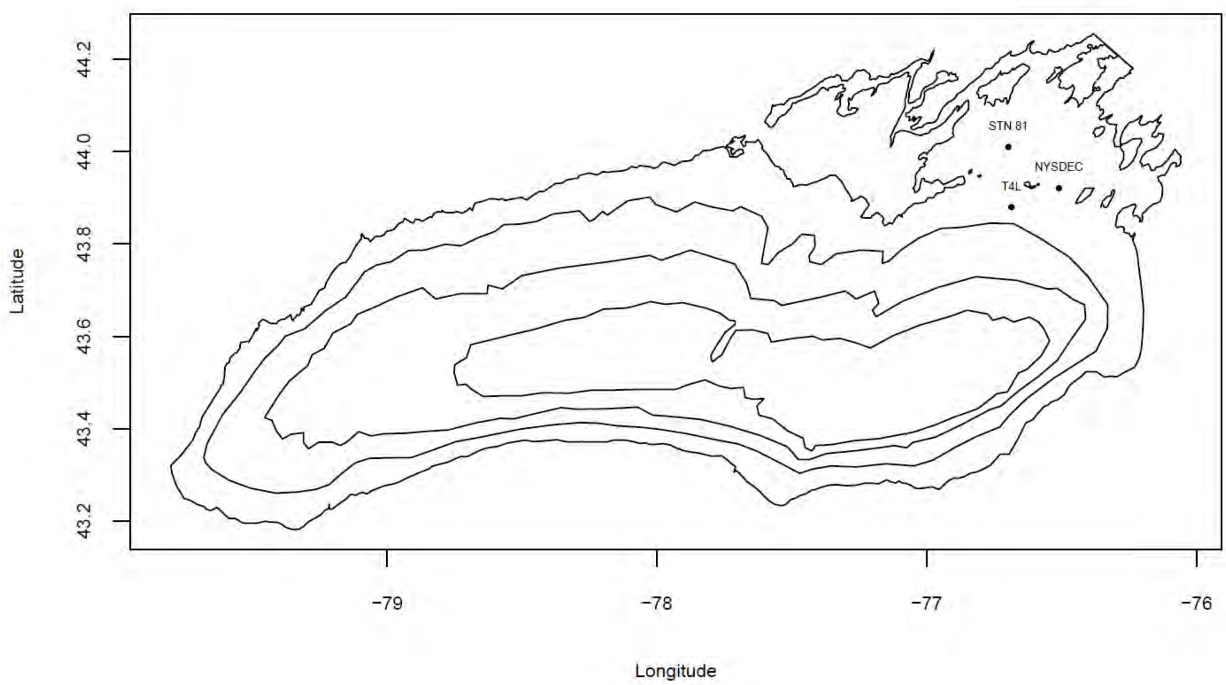


FIG. 9.7.1. Map of Lake Ontario showing the locations of all three sampling sites.

In 2018, stratification of the water column (when the thermal gradient from surface to bottom waters of the lake are greatest, and the lake resists mixing) was first observed on June 26th at all three of the sites and was last observed on October 3rd. Average depth of the thermocline was similar for both Station 81 and NYSDEC, but was slightly shallower in the water column at T4L (Table 9.7.1).

Mean epilimnetic (the upper warmer layers of the lake where much of the biological processes occur) water temperature ranged from 5.1°C in early-May to 22.0°C in mid-July at Station 81. Peak temperatures were slightly cooler at T4L and NYSDEC. Water transparency (a crude measure of the amount of microscopic life in the water column) was greatest at Station 81 in May (15 m) and decreased steadily (as the epilimnetic waters warmed) to a low of 3.3 m in September. T4L showed a similar trend. Across the three plus decade time series, mean annual epilimnetic water temperature continues to show a warming trend, suggesting the average water temperatures of the upper layers of the lake are increasing 0.03°C per year (Fig. 9.7.2). Lastly, nutrient, phytoplankton, and zooplankton samples collected in 2018 are currently being analyzed and will allow us to examine plankton community composition, biomass, and production, and relate that information to fishery assessment activities co-occurring in that region.

Long-term monitoring programs such as Station 81 provide scientists and managers with baseline information on the smallest organisms that form the base of the Lake Ontario foodweb. By understanding "normal" ranges of various physical, chemical, and biological components of the ecosystem, managers will be able to better identify and respond to ecosystem changes that may have implications for the fishery. The addition of greater spatial coverage will help us to determine if observed changes are localized or more wide-spread.

TABLE 9.7.1. Average, maximum, and minimum depths of the thermocline at all three sampling sites in Lake Ontario. All data was collected from May 7 – November 1, 2018.

	STN 81	T4L	NYSDEC
Mean	17.75	16.25	17.13
Max	26.0	22.0	29
Min	10.5	11.0	11.5

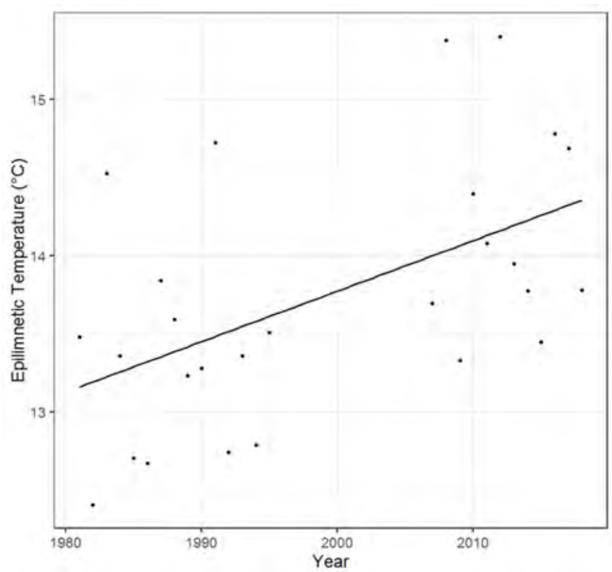


FIG. 9.7.2. Mean annual epilimnetic water temperature calculated at Station 81 for years sampled from 1980 to 2018 (note: no sampling occurred from 1996-2006). Black dot represents mean. Black line represents a "line of best fit" ($R^2 \sim 25\%$).

9.8 Application of a habitat suitability and natural dispersal model for invasive species in the Great Lakes.

Project Leads: Jeff Buckley and Tim Johnson (OMNRF, Aquatic Research and Monitoring Section), Len Hunt (OMNRF, Centre For Northern Forest Ecosystem Research), Andrew Drake (Fisheries and Oceans Canada)

Invasive species pose a threat to the function and diversity of native aquatic communities. In collaboration with partners at the Centre for Northern Forest Ecosystem Research and Fisheries and Oceans Canada, we have continued work on a vulnerability assessment of Ontario and the Great Lakes to the spread and establishment of aquatic invasive species (AIS). This year we have focused on developing models of habitat suitability and natural spread of invaders for the Great Lakes.

To model the suitability of habitat for aquatic species within the Great Lakes we used four key environmental variables: temperature, depth, shoreline exposure, and nutrient loading. The Great Lakes Aquatic Habitat Framework (GLAHF, www.glahf.org, Riseng *et al.* 2018) have compiled data on these and other variables into a standardized and easily accessible framework with full, detailed, coverage across the entire Great Lakes region. Habitat preference and survival limits for individual invasive species and functional groups were determined through detailed literature reviews (e.g., Hatton *et al.* 2018). The GLAHF habitat data were combined with the species preferences and tolerances to generate a final habitat suitability score for a given AIS. For example, Fig. 9.8.1 shows the predicted suitable habitat for a small, warm-water AIS within the Great Lakes.

To model the potential natural spread of invasive species we have implemented Circuitscape models developed by Shah & McRae (2008). Introduced species tend to move toward areas of nearby suitable habitat. That is, they move along the path of least resistance in the same way that electricity flows across the path of least resistance in a circuit. In aquatic systems, these circuits consist of lakes and connecting channels (rivers & streams). Circuitscape uses these principles of electrical flow, using our habitat suitability index as the underlying measure of "resistance", to predict likely movement paths for individuals across the Great Lakes.

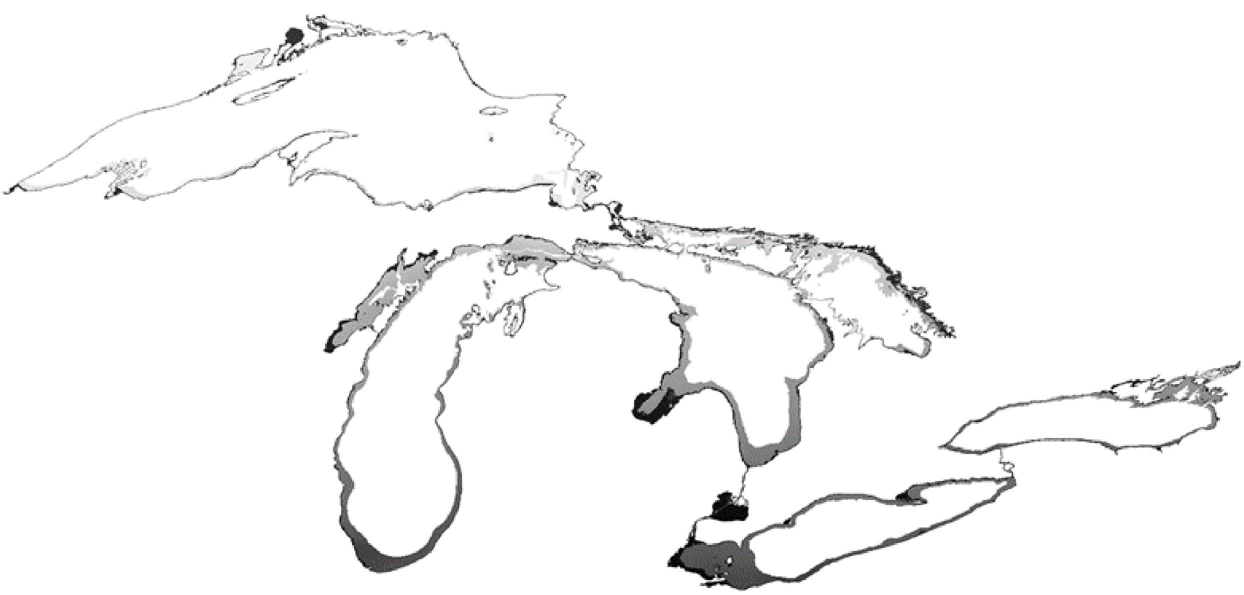


FIG. 9.8.1. Relative habitat suitability in the Great Lakes for a small, warm-water fish species. Darker areas indicate a higher suitability and therefore higher likelihood of survival and establishment.

These models will ultimately be pieces of a larger assessment of the vulnerability of Ontario and the Great Lakes to AIS spread and establishment. Habitat suitability models help to determine where potential invaders will be more likely to survive and become established. Dispersal models help us determine where invaders are likely to end-up after they are introduced, as well as allow us to identify important corridors of spread that can be targeted for monitoring. In the upcoming year, we will complete an integration of these models with models predicting human-mediated spread to generate a more complete representation of the vulnerability of Ontario waters to AIS spread.

Hatton, E.C., J.D. Buckley, S. Fera, S. Henry, L.M. Hunt, D.A.R. Drake and T.B. Johnson. 2018. Ecological temperature metrics for invasive fishes in Ontario and the Great Lakes Region. Ontario Ministry of Natural Resources and Forestry, Science and Research Branch, Peterborough, ON. Science and Research Information Report IR-15. 27 p. + append.

Riseng, C. M., Wehrly, K. E., Wang, L., Rutherford, E. S., McKenna, J. E., Johnson, L. B., … Sowa, S. P. (2017). Ecosystem classification and mapping of the Laurentian Great Lakes. *Canadian Journal of Fisheries and Aquatic Sciences*, *1712*(2017), 1–20.

Shah,V.B. and B.H. McRae. 2008. Circuitscape: a tool for landscape ecology. In: G. Varoquaux, T. Vaught, J. Millman (Eds.). Proceedings of the 7th Python in Science Conference (SciPy 2008), pp. 62-66.

9.9 Current and potential aquatic invasive species in Ontario: species identification and synthesis of ecological information

Project Leads: Elizabeth Hatton, Jeff Buckley, Tim Johnson (OMNRF, Aquatic Research and Monitoring Section); Len Hunt (OMNRF, Centre For Northern Forest Ecosystem Research); Andrew Drake (Fisheries and Oceans Canada)

As part of a larger effort to develop a risk assessment tool to predict the distribution and spread of nonindigenous aquatic invasive species (AIS) in Ontario, we compiled existing information about current and possible future AIS in Ontario and the Great Lakes Region (GLR), focusing on their geographic origins, likely pathways of arrival and spread, ecological characteristics, and generalized ecological impacts.

The final analysis included a combined total of 206 fish, invertebrate, and plant species. The species list was developed using two distinct categories of species (Fig. 9.9.1): (1) **current AIS** that have established populations in Ontario or the GLR that could spread further within the region, and (2a) **potential AIS** that have not established in the GLR but elsewhere in North America or (2b) other continents.

Nearly three quarters of the species are indigenous to Eurasia and are primarily associated with aquarium / water garden (61%) or commercial shipping (37%) pathways (Fig. 9.9.2). Once established in the GLR, secondary spread is linked to recreational boating, canals, commercial shipping, and bait release. Body size ranges from microns to metres, although the majority are small and / or produce small seeds making detection and control challenging.

Collectively, the species show a wide range of tolerances for temperature and salinity and will distribute across all types of aquatic habitat. Age at reproductive maturity and longevity for fish and invertebrates is highly variable and spans days to decades. Plants are largely perennials (84%), are distributed among multiple growth habits, and most possess both sexual (flowering) and asexual (predominantly fragmentation and rhizomes) reproductive strategies. Invertebrates reproduce sexually (98%), although 24% can also generate offspring asexually. Most fish species (56%) spawn without guarding their clutch, although 36% guard their young. Fish and invertebrates are

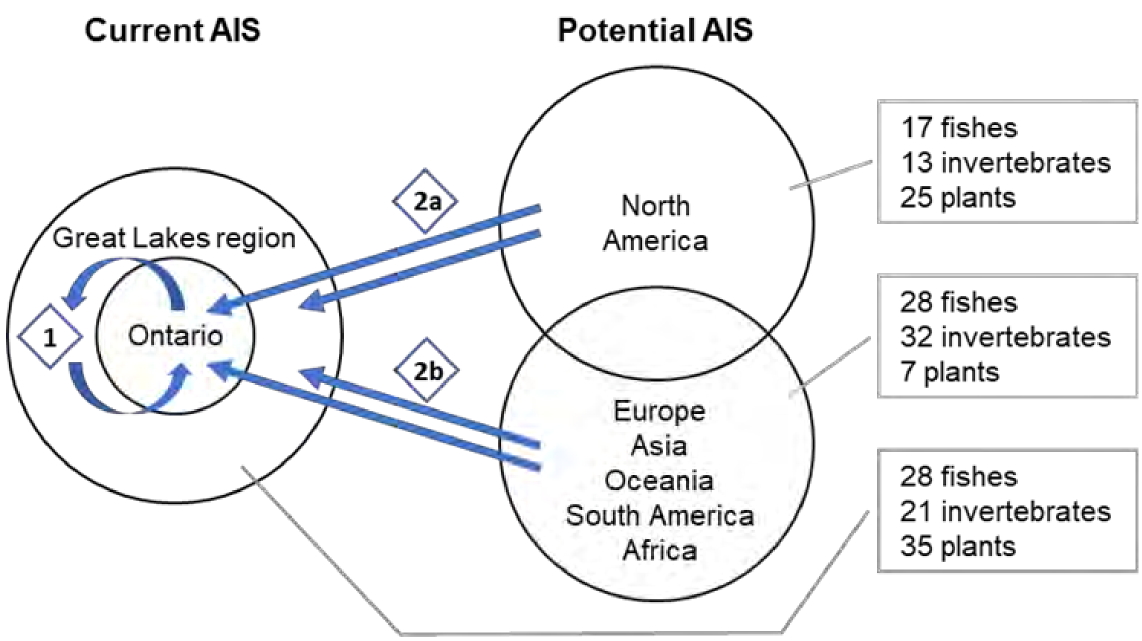


FIG. 9.9.1. Conceptual diagram reflecting the general categories of AIS used in this analysis based on indigenous origin and pathways for spread. Current (2018) established species counts for fishes, invertebrates and plants for each category.

predominantly omnivores and, for fish, also carnivores suggesting possible broad food web impacts. The greatest knowledge gaps in ecological information exist for invertebrate and plant species, while potential fish invaders are generally better understood.

Current and anticipated adverse ecological impacts of invaders include moderate to high resource competition, nuisance growth (clogging infrastructure and waterways), declines in indigenous species, ecosystem changes (including food web and habitat alterations), and/or new vectors for disease.

An OMNRF Science and Research Branch Information Report is undergoing publication. The information contained within the report will provide a more complete understanding of the ecological, physiological, and behavioural characteristics of aquatic invasive species needed to manage the risk associated with their potential arrival and spread.

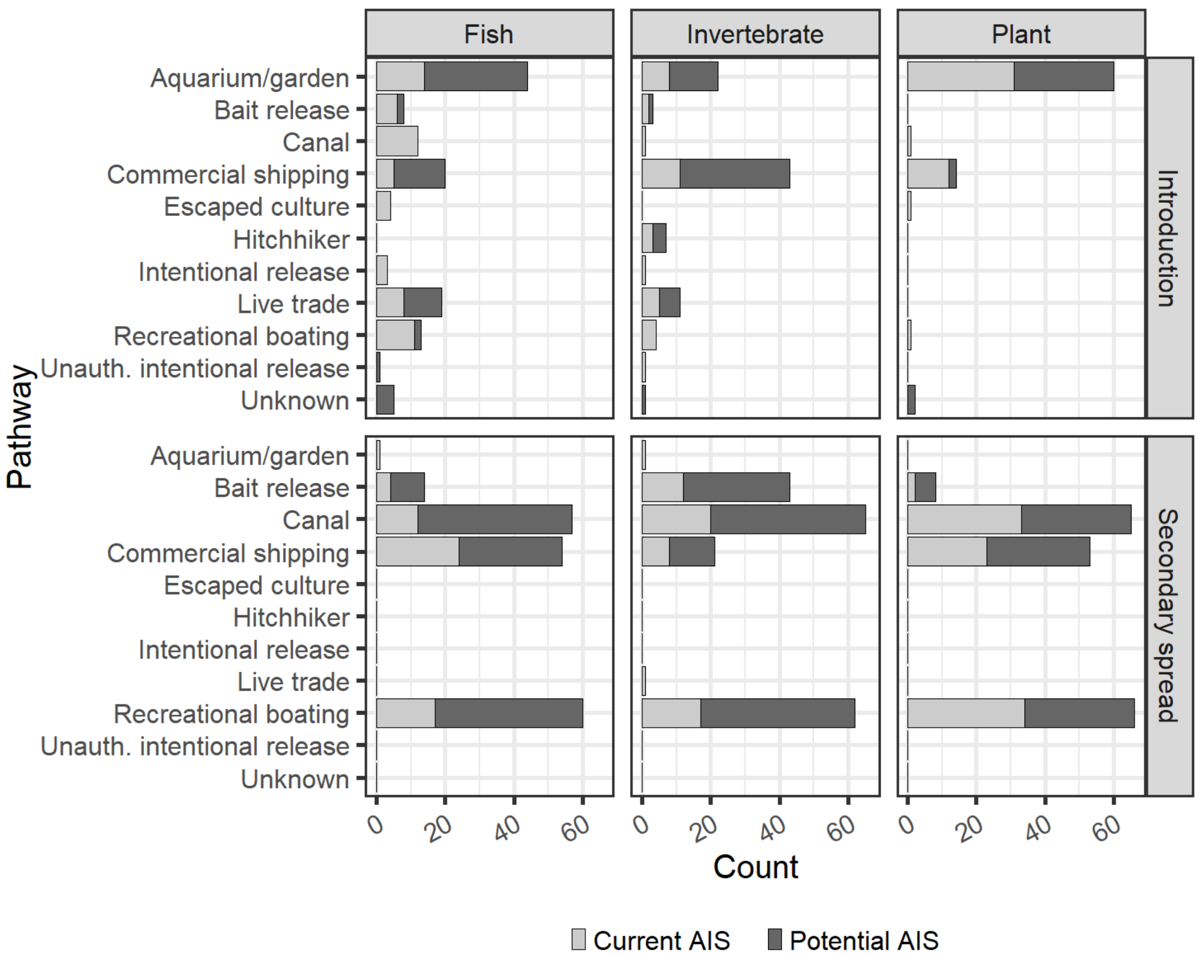


FIG. 9.9.2. Initial pathways of entry (initial introduction to the GLR) and secondary spread (movement within the GLR) for current and potential non-indigenous fish, invertebrate, and plant species to the Great Lakes region.

9.10 Species distribution models for aquatic invasive species screening assessments

Project Leads: Caleb Yee and Shelley Arnott (Queens University); Tim Johnson (OMNRF, Aquatic Research and Monitoring Section)

Aquatic invasive species (AIS) are a leading cause of biodiversity loss in North American lakes, river and streams. Once AIS establish, they can change food webs and alter the physical or chemical conditions of a waterbody. Management actions have focused on preventing the establishment of new invaders because once established AIS are difficult and expensive to control, and nearly impossible to eradicate. Detailed risk assessments provide the best available scientific advice about the likelihood of a species arriving, establishing, and impacting recipient ecosystems; such information is essential for management intervention and response. However, detailed risk assessments are time-consuming and expensive to conduct. With many possible invaders, conducting detailed risk assessments for all of them is a daunting task. Screening potential invaders before detailed risk assessments are conducted could highlight high-risk invaders, and increase the efficiency of the risk assessment process.

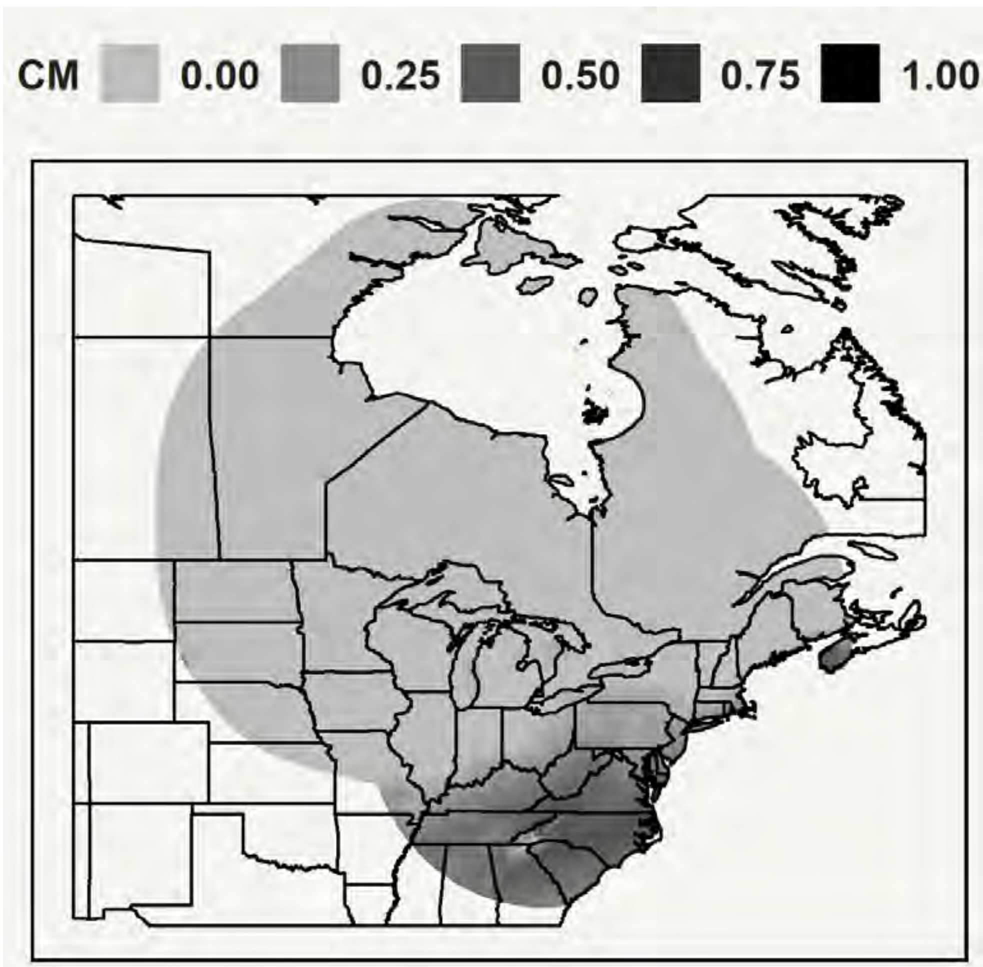


FIG. 9.10.1. Climate matching for Round Goby (*N. melanostomus*) in the Laurentian Great Lakes region based on occurrence records outside of North America. Low climate matching is seen in Ontario suggesting round goby should not establish in Ontario; however, Round Goby is well established in Southern Ontario revealing the limitations of solely relying on one tool (climate matching) to inform potential risk of establishment.

Climate matching using species distribution models is a common element of AIS screening tools. Invaders are more likely to establish in regions with similar climate to their native range. Species distribution models compare the climate conditions where an invader is present to the climate conditions in the target region. For climate matching to be an effective screening method it must identify all species that have a high likelihood of establishing or else risky invaders could be omitted from detailed risk assessments and management actions. This project sought to assess the effectiveness of climate matching as a screening tool for aquatic invasive species in temperate climates similar to Ontario.

Eighteen invasive fishes established in the Laurentian Great Lakes region were used to test the ability of climate matching to predict a species invasion before their establishment. Domain species distribution models were used to evaluate the climate similarity between a fishes' occurrences records outside of North America to the fishes' occurrences in the Laurentian Great Lakes Region. The climate conditions compared were: growing degree days above 0^{0}C (a measure of air temperature), total annual precipitation, and variation in temperature over a year (standard deviation in temperature).

Generally, climate matches were high for established invaders (mean climate similarity = 0.45±0.24SD). However, four fishes [Round Roby (*Neogobius melanostomus*), Tubenose Goby (*Proterorhinus marmoratus*), Blue Tilapia (*Oreochromis aureus*), and Nile Tilapia (*Oreochromis niloticus*)], have established occurrences in areas with no climate similarity to their non-North America occurrences. Of concern is *N. melanostomus* (Round Goby, Fig. 9.10.1) because this successful invader showed low climate similarity at all occurrences in the Laurentian Great Lakes region (mean climate similarity = 0.01 ± 0.02SD). Although invaders can establish in areas with low climate similarity, climate matching was able to predict relative likelihood for establishment (e.g., fish A was more likely to be found in an area of 0.3 climate similarity than an area of 0.1 climate similarity).

Climate matching should not be used as a stand-alone screening tool, but it should continue to be incorporated into detailed risk assessments. The ability of fishes to establish in areas with low climate similarity compared to their previous occurrences indicates that using climate matching as a screening tool could potentially omit pursuing assessments of high impact invaders like *N. melanostomus*, resulting in unforeseen invasions. Climate matching was able to predict the relative likelihood of a fishes' occurrence indicating the most at-risk areas. Using climate matching in detailed risk assessments would help to identify at risk areas where early detection and management actions should be focused leading to more efficient use of resources.

9.11 Efficacy of recreational watercraft decontamination methods to reduce the overland dispersal of aquatic invasive species: a literature review.

Project Leads: Shrisha Mohit and Shelley Arnott (Queen's University); Tim Johnson (OMNRF, Aquatic Research and Monitoring Section)
Collaborators: Jeff Brinsmead (OMNRF, Natural Heritage Policy Section)

Recreational boating activities are known to facilitate the spread of aquatic invasive species (AIS). Invertebrate and plant AIS can be transported in, or entangled on, boats, trailers, propellers, or in bilge and live wells and therefore be potentially introduced to new, uninvaded environments. To minimise this risk, the Ontario Ministry of Natural Resources and Forestry (OMNRF) recommends that outdoor enthusiasts decontaminate pleasure craft, fishing, sailing, or watersports gear by using a high-water pressure washer, rinsing with hot water, and / or air drying for two to seven days. However, the efficacy of these measures against various AIS is unknown. Hence, this project undertook a review of the scientific literature published until 2018 to assess the state of knowledge on efficiently controlling AIS through watercraft decontamination (Fig. 9.11.1).

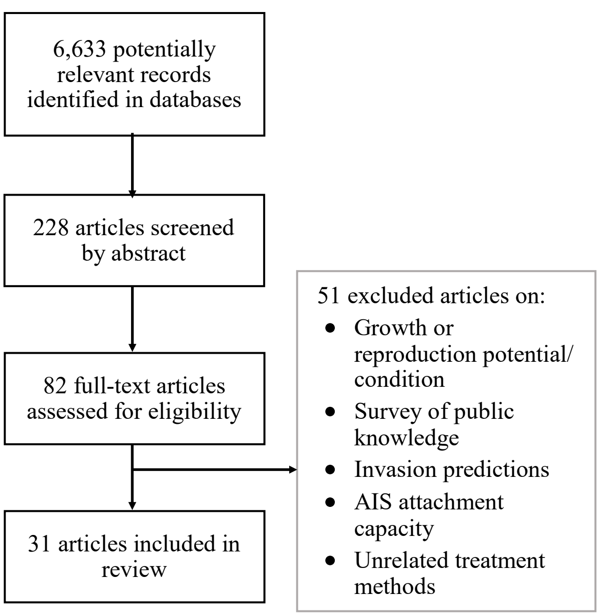


FIG. 9.11.1. Flow-diagram illustrating the selection process for publications included in the review

The literature review identified 82 full-text articles on preventing freshwater AIS spread, as well as plant and invertebrate AIS response to heat, pressure-washing, desiccation or cleaning agents. Of these, 31 were included in the review as they investigated experimental procedures specific to inhibiting the transport of organisms aboard recreational watercraft and equipment. Most studies focussed on a single decontamination method or AIS, resulting in a paucity of information about other potentially effective measures and equally threatening organisms (Table 9.11.1)

Effects of air-drying

Most studies (71%) investigated air exposure. Some AIS invertebrates that were studied included Zebra Mussels (*Dreissena polymorpha*), Quagga Mussels (*D. bugensis*), snails, and non-native crayfish. Eight studies assessed whether the age or size of individuals of the same invertebrate species affected their tolerance to desiccation; all reported that younger or smaller individuals had lower resistance. Under summer-like conditions, 100% of adults from three mussel species died within 2-7 days of air-drying, compared to 3h for larvae. Aquatic snails, on the contrary, rarely reached 50% mortality after air-drying for one week. These results indicate that the 2-7 days of air-drying recommended by the OMNRF may be effective against certain invertebrate AIS only, when relative humidity is low. For aquatic plants water loss was inversely associated with fragment survival or growth, with short or single fragments being less resistant than larger or bundled pieces. Interestingly, after 5h of desiccation, 95%-100% mortality occurred among small fragments of three aquatic plants that threaten the freshwater bodies of Ontario, namely hydrilla (*Hydrilla verticillata*), fanwort (*Cabomba caroliniana*), and Eurasian watermilfoil (*Myriophyllum spicatum*).

TABLE 9.11.1. Distribution of decontamination methods and AIS appearing in selected articles.

Decontamination methods	Number of articles	Invasive organisms studied	Number of articles
Air-drying or desiccation	24	Zebra, quagga or golden mussels	13
Hot-water	7	Aquatic plants (including 16 species)	10*
Pressure-washing	1	Aquatic snails	7
Others	2	Non-native crayfish	2
More than one method	3	Killer shrimp	2
		Spiny waterflea	2
		Bloody-red shrimp	1
		More than one organism	7

*Eurasian watermilfoil was the most commonly studied aquatic invasive plant, appearing in 6 studies.

Effects of hot water

Seven studies (23%) assessed how hot water affected AIS survival. Most investigated mortality after prolonged immersion in hot water; among all the studies 100% mortality was observed for two mussel species, Bloody-red Shrimp (*Hemimysis anomala*), Spiny Waterflea (*Bythotrephes longimanus*), Killer Shrimp (*Dikerogammarus villosus*), and four aquatic plants (fragments of *Hydrocotyle ranunculoides*, *Lagarosiphon major*, *M. spicatum*, and *M. aquaticum*) when exposed to a minimum of 50^{o}C water for 15 minutes. Two studies tested hot water sprays, which involved shorter exposure times than immersion. The results showed that contact with water at 60^{o}C resulted in 100% mortality among zebra and quagga mussels when applied for 5 and 10 seconds, respectively. These findings indicate that the effectiveness of hot water as a decontamination tool depends on the mode and duration of application, e.g., spray washing for boats and trailers, or immersion of smaller equipment.

Effects of pressure-washing

Only one study assessed the efficacy of pressure-washing. Overall, the study found that visual inspection and manual removal, or high pressure washing (1800 psi) were more effective than low pressure washing at removing large fragments or entangled aquatic plants. However, high pressure was significantly more effective at removing small-bodied organisms or plant material (e.g., seeds) than visual inspection and manual removal, or low pressure-washing. It is important to note that the pressure reported here is more representative of gas-powered pressure washers, which generate considerably higher pressure than electric models typically used by private homeowners.

Other decontamination methods

Two studies reported the effects of “common” chemical treatments on AIS mortality, namely salt and sodium hypochlorite (bleach) solutions. The first found that 100% of quagga mussels died after 40h of immersion in salt water at concentrations close to seawater (33.4 ppt), whereas bleach killed 100% of killer shrimps instantly at a concentration of 10,000 mg/L (20% dilution of household bleach), and after 8 min of exposure at a concentration of 5,000 mg/L (10%). Exact amounts of cleaning agents hence need to be calculated and used to produce a lethal effect on AIS.

Overall, this review reveals vast differences in the techniques used to assess the efficacy of different treatments, and the response of AIS. As most studies assessed only one species and a single decontamination method, the results may not be applicable to the diversity of AIS present in a region. To determine which decontamination measures would be most effective against various AIS, while also remaining practical, further studies are necessary to assess each recommendation separately and in combination on several species simultaneously.

9.12 Cooperative Science and Monitoring Initiative: Lake-wide Multi-agency Foodweb Investigations on Lake Ontario in 2018

Project Leads: Tim Johnson and Adam Rupnik (OMNRF, Aquatic Research and Monitoring Section); Aaron Fisk (University of Windsor, Great Lakes Institute for Environmental Research)
Collaborators: Jeremy Holden (OMNRF, Lake Ontario Management Unit); Brian Weidel (United States Geological Survey); Michael Connerton (New York State Department of Environmental Conservation); Warren Currie and Kelly Bowen (Fisheries and Oceans Canada); Jacques Rinchard (SUNY-Brockport); Matt Bond and David Rowan (Canadian Nuclear Laboratories); Michael Rennie (Lakehead University)

The Great Lakes Water Quality Agreement between Canada and the United States outlines a binational Cooperative Science and Monitoring Initiative (CSMI) for each of the Great Lakes on a five-year rotational basis (see Section 10.1). This initiative addresses priorities identified through the Lakewide Action and Management Plan (LaMP) process. One project identified for 2018 focussed on learning more about foodweb dynamics and the distribution and behaviour of fishes in Lake Ontario.

The multi-institutional research and monitoring effort was conducted on a whole-lake scale from April to October 2018. This effort targeted predator and prey fishes, and zooplankton (with limited benthic invertebrate sampling) from nearshore (<70m) and offshore (>70m) depths in six pre-defined ecoregions. Previous analyses, including the 2013 CSMI, had identified these ecoregions as exhibiting discrete limnological and / or foodweb properties. In total, over 700 predator fish, 2,500 prey fish, and 150 invertebrate samples were collected throughout Lake Ontario (Fig. 9.12.1).

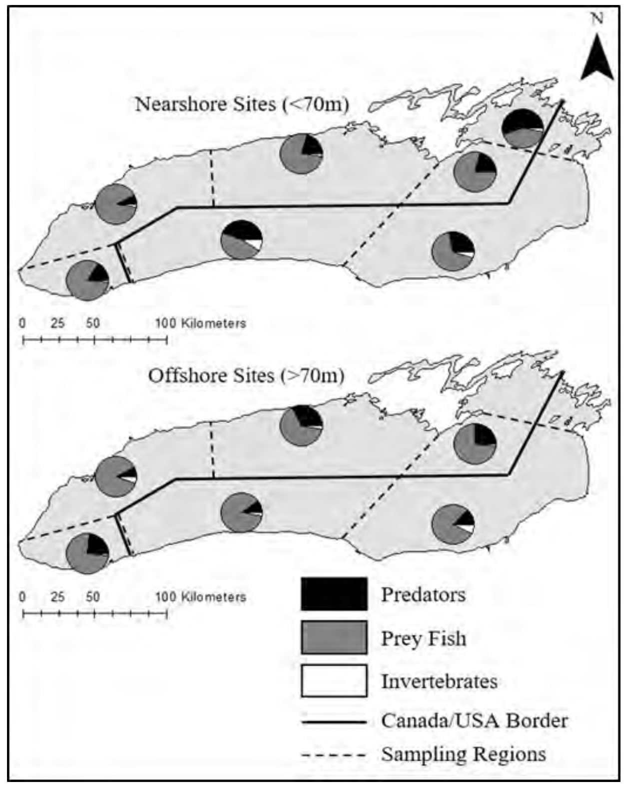


FIG. 9.12.1. Number of samples collected throughout Lake Ontario for the 2018 CSMI initiative. Pie charts represent the proportion of predator fish, prey fish, and invertebrates caught at each location for both nearshore (< 70m) and offshore (> 70m) sampling sites. Dashed lines reflect ecoregion boundaries. There is no pie chart present for the offshore site within the Eastern Basin as the depth in this area does not exceed 70m.

A lake-wide survey of this scale required dedication and hard work of numerous crews, vessels, administrative staff, and technicians. OMNRF's *Ontario Explorer*, USGS' *RV Kaho,* and NYSDEC's *Seth Green* were the primary offshore fisheries vessels, while the US-EPA's *Lake Guardian,* Canadian Coast Guard's *Limnos* and DFO's *Cisco* were the primary lower trophic level platforms providing seasonal surveys spanning nearshore to offshore locations. Small vessels including OMNRF's *C.R Wood, Seacow,* and *PeeWee*, USGS' *RV Lacustris,* and DFO's

Leslie J filled in collections when large vessels were unavailable or unable to access shallower sites.

Secondary processing and analysis of over 3,500 individual samples is now underway, including species composition, size and age information, diets, and tissue samples for various measures of foodweb function. Planning meetings before field work began identified several research initiatives investigating different aspects of the Lake Ontario foodweb. Through these meetings we developed a protocol whereby the same sample (individual fish or invertebrate sample) would be shared among research groups, facilitating potential future comparison of outcomes to provide a much more robust understanding of foodweb dynamics. Collaborating research groups included University of Windsor (stable isotope analysis to describe general foodweb structure), Lakehead University (mercury dynamics to understand efficiency of energy flow), SUNY Brockport (thiamine and fatty acid analyses to understand impediments to reproduction related to invasive species), and Canadian Nuclear Laboratories (radioisotopes and trace elements to describe distribution and fate of biologically incorporated pollutants). These initiatives will aid in understanding the current constraints to production within Lake Ontario, allow for comparisons to 2008 and 2013 CSMI years, and provide sound science that can advise management decisions for the Great Lakes region.

9.13 Chinook Salmon Otolith Microchemistry

L. Johnson and M. J. Yuille, Lake Ontario Management Unit

Understanding the magnitude of natural reproduction of salmon and trout populations is vital in managing for sustainable fisheries as well as maintaining a healthy predator-prey balance in the Great Lakes. In the past, natural reproduction was thought to contribute minimally to the recreationally important Salmon and Trout populations of Lake Ontario. In recent years, following the Chinook Salmon mark and tag program in Lake Ontario (see Section 7.1), it was determined that naturally produced Chinook Salmon represent an average of half of the Chinook Salmon in Lake Ontario. The contribution of natural fish to the lake population varies from year to year (30-60%; see 2015 Lake Ontario Management Unit Annual Report, Section 2.2); understanding this variability is critical to maintaining a healthy predator-prey balance.

Clipping and/or implanting coded wire tags in stocked fish allows for an easy visual identification of stocked (clipped/tagged) and naturalized (no clip/tag) fish but can be expensive and require multi-year program commitments for data (mark and tag) recovery. In recent years, otolith microchemistry has been used as a technique to assess the natal origin of fish. Otoliths are composed of a crystalline calcium carbonate structure that accretes layers throughout the life of the fish. Within these calcium carbonate layers, other chemicals are deposited in trace amounts and are proportional to that of the water in which the fish is inhabiting. These layers create a temporal and geographical signature or "fingerprint" unique to the water in which the fish was born and lived early in its life. These microchemical "fingerprints" in the fish otoliths could be used to determine whether a fish (e.g., Chinook Salmon) was stocked or naturally produced and if naturally produced, which river in Lake Ontario it was born.

The long-term goal of this study is to develop a methodology for differentiating sources of Chinook Salmon production in Lake Ontario (i.e., hatchery or naturalized origin and if naturalized, which river/stream). The objective on the work described here is to develop a technique that can be applied to adult salmon and trout to determine their natal origin. We examined water chemistry data from four tributaries of Lake Ontario (Bronte Creek, Ganaraska River, Wilmot Creek, and Duffins Creek) provided by the Provincial (Stream) Water Quality Monitoring Network (Ministry of Environment, Conservation and Parks, available at: https://www.ontario.ca/data/provincial-stream-water-quality-monitoring-network), looking for differences in elemental concentrations that could distinguish individual tributaries. Otolith microchemistry on the core of otoliths from 100 naturally produced smolts collected from seven tributaries (Bronte Creek, Credit River, Oakville Creek, Duffins Creek, Wilmot Creek, Ganaraska River and Shelter Valley Creek) was conducted at the Great Lakes Institute for Environmental Research (Element and Heavy Isotope Analytical Laboratories, University of Windsor). The core of the otolith corresponds to the earliest larval period of the fish's life, thus the microchemistry of the core of the otolith was used as a means of inferring natal origin of fish.

Preliminary results show that all four tributaries examined can be distinguished from each other based on the differing concentrations of trace elements (Fig. 9.13.1). Smolt otolith microchemistry results showed some overlap in trace element concentrations but at a coarse level; fish grouped into two categories corresponding to the prominent geologic feature in their respective headwaters (Niagara Escarpment and Oak Ridges Moraine) in which they were collected (Fig. 9.13.2). Smolts from the Niagara Escarpment tributaries (Bronte Creek, Credit River and Oakville Creek) were associated with higher elemental concentrations of magnesium, strontium and manganese whereas fish from the Oak Ridges Moraine tributaries (Duffins Creek, Wilmot Creek, Ganaraska River and Shelter Valley Creek) were associated with higher levels of barium and calcium.

In 2019, further analysis will incorporate Chinook Salmon smolts from both Ontario and

New York State hatcheries as well as Ontario and New York State Chinook Salmon net pens (Section 6.1).

This research adds to the body of literature examining assessment techniques differentiating hatchery vs. naturalized fishes. This technique may lead to a new approach to determine natal origin of not only Chinook Salmon, but of all stocked salmon and trout in Lake Ontario. This information is critical to successfully managing Lake Ontario's salmon and trout populations and maintaining a healthy predator-prey balance. Additionally, it may provide insight into the sources (streams and rivers) of natural production in Lake Ontario.

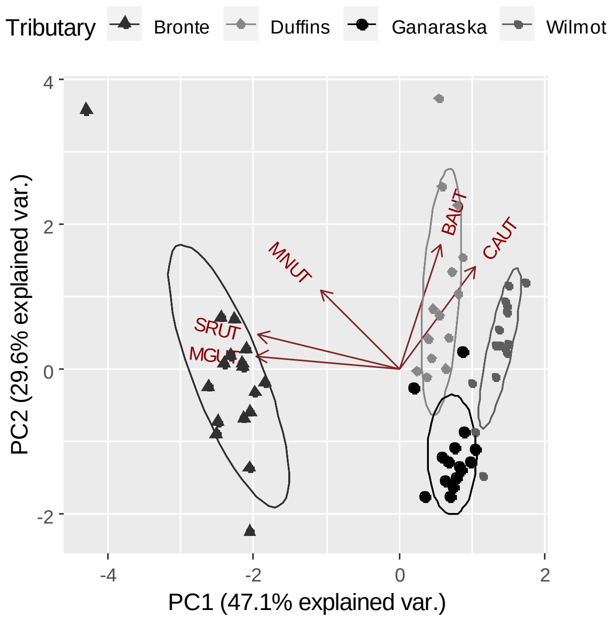


FIG. 9.13.1. Principle component analysis of water chemistry data from four tributaries of Lake Ontario. Principle component axes 1 and 2 explain 47.1% and 29.6% (respectively) of the variability in the data. MNUT = manganese, SRUT = strontium, MGUT = magnesium, CAUT = Calcium, and BAUT = barium.

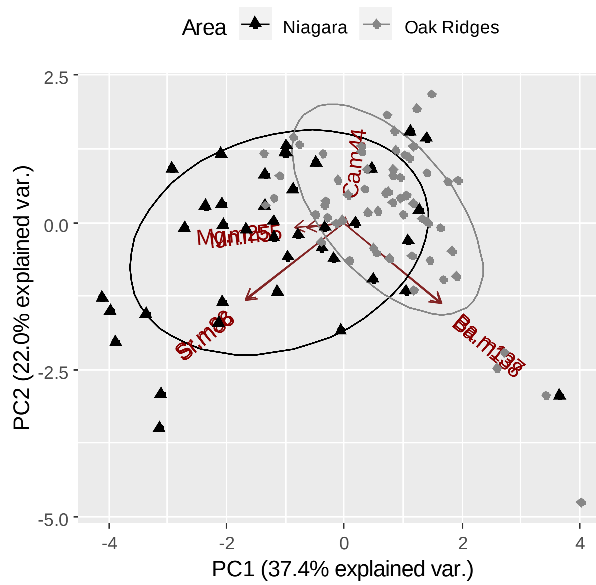


FIG. 9.13.2 Principle component analysis of Chinook Salmon smolt otolith microchemistry data from seven Lake Ontario tributaries in the Niagara Escarpment (Bronte Creek, Credit River, Oakville Creek) and Oak Ridges Moraine (Duffins Creek, Wilmot Creek, Ganaraska River and Shelter Valley Creek). Area groupings based on the prominent geologic feature in their respective headwaters; Niagara Escarpment and Oak Ridges Moraine. Principle component axes 1 and 2 explain 37.4% and 22.0% (respectively) of the variability in the data. Ca.m44 = Calcium, Mg.m25 = magnesium, Mn.m55 = manganese, Sr.m86 & Sr.m88 = strontium, Ba.m137 & Ba.m138 = Barium.

9.14 Effect of first year growth on Chinook Salmon (*Onchorynchus tshawytcha*) spawning size and age in Lake Ontario

L. Johnson, M. Yuille and J. Holden, Lake Ontario Management Unit
O. Gemmell and B. Tufts, Queens University

Interest in growth and life history of salmonids has increased over the past couple of decades as researchers have reported evidence for declining size and age at maturity in many species of Pacific salmon in the Great Lakes. In addition, fisheries managers interested in balancing salmonid stocking levels with prey abundance in the Great Lakes (Section 7.1) recognize the importance of these changes. Age at maturity is an important life history attribute in anadromous salmon that represents a balance between survival and reproductive fitness. Older individuals are larger, able to invest more energy into reproduction, produce more gametes and are better competitors on spawning grounds. However, the older a fish gets, the higher the risk of mortality due to natural or fishery induced causes. Alternatively, spawning early provides the advantage of increased survival to maturity, but reproductive fitness may be lower than that of an older fish. Understanding the factors that influence age at maturation is necessary for maintaining variation and promoting persistence of these populations.

The proportion of fish that spawn at an early age is often related to the size of smolts when they leave the tributaries. Studies on Pacific salmon in their natural habitats have inferred that greater first year growth affects age at maturation, with larger juveniles spawning earlier than fish with less first year growth. Fast growing individuals tend to mature earlier than slower growing individuals. There is a lack of information on how first year growth affects salmonid size and spawning age in the Laurentian Great Lakes. With potential increases in first year growth due to advancements in hatchery/stocking techniques (Section 6.1) and observed trends for longer growing seasons in the Great Lakes (Section 11.1), it is increasingly important to determine the effect of first year growth on the size and age at maturity of these highly sought-after fish

We used measurements of otolith growth increments to infer first year growth in adult spawning Chinook Salmon and determine how first year growth affects the age and subsequently size at sexual maturity of Chinook Salmon in Lake Ontario, specifically fish returning to spawn at the Credit River. The Credit River is comprised of both natural and stocked fish; recovery of adipose-clipped (which indicates hatchery origin) Chinook Salmon from spawning surveys shows 87% of adult returns are of hatchery origin (see Section 2.2 - Chinook Salmon Mark and Tag Monitoring, 2015 Lake Ontario Management Unit Annual Report). By comparing direct stocked hatchery fish to naturally produced fish we evaluated if hatchery origin influenced first year growth. Additionally, we examined the effect of first year growth on spawning age of Chinook Salmon in the Credit River as well as the overall trend in size over time and the proportion of young spawning fish through time. We hypothesized that increased first year growth would lead to younger age at maturity.

From 2008 to 2011 Chinook Salmon stocked into Lake Ontario were marked via adipose clip distinguishing them from naturalized fish (adipose intact; see Section 7.1). Using the 2008-2011 cohorts, we did not find a significant difference in first year otolith growth between stocked (adipose clipped) and naturally produced (adipose intact) Chinook Salmon (Fig. 9.14.1). The average fork length of both male and female spawning Chinook Salmon in the Credit River declined from 1992 to 2016, while the proportion of young (age 1 and 2) spawning fish has significantly increased through this time period (Fig. 9.14.2). We found increased first year otolith growth did not significantly affect age at maturity for male fish; however increased first year otolith growth in females was associated with younger spawning ages (Fig. 9.14.2).

The findings in this study add to a growing body of evidence that increased first year size contributes to early maturation in Chinook Salmon. Increased first year growth led to younger spawning female Chinook Salmon, whereas there was no effect of first year growth on male spawning age. This study underlines the complexity associated with age at maturation in Chinook Salmon and suggests there are a multitude of factors contributing to this specific component in their life history. Our ability to differentiate stocked and natural fish was limited to a short time frame (2008 – 2011 cohorts); just prior to the significant increase in hatchery smolt size. Therefore, as stocked smolt size increases and diverges further from naturally produced fish, Lake Ontario may continue to see a shift towards earlier maturation and an overall reduction in size. Future work is needed to examine the importance of genetic and environmental factors affecting age at maturity in this population. If the population shifts towards a younger age of maturity it may result in smaller fish being caught in the recreational fishery and could make the population less diverse and less resilient to environmental changes. A more holistic approach, incorporating both genetic inheritance as well as environmental variability is warranted to fully understand the dynamic of first year growth and age at maturity in Chinook Salmon.

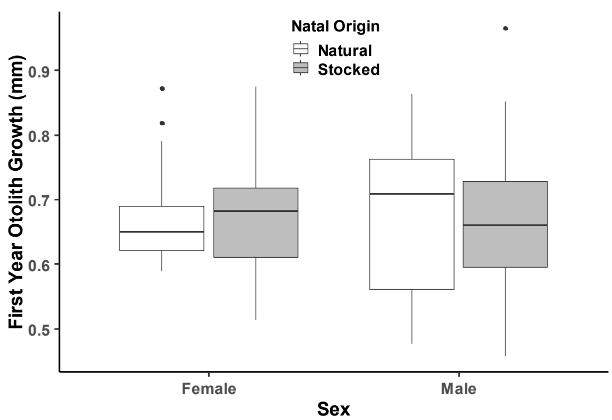


FIG. 9.14.1. Comparison of first year otolith growth (mm) between female and male, naturalized (white) and stocked (grey) mature Lake Ontario Chinook salmon returning to the Credit River during the fall spawn. 2008 to 2011 cohorts only were used for this comparison as those stocked were marked via adipose clip, thus distinguishing them from naturalized fish (adipose intact).

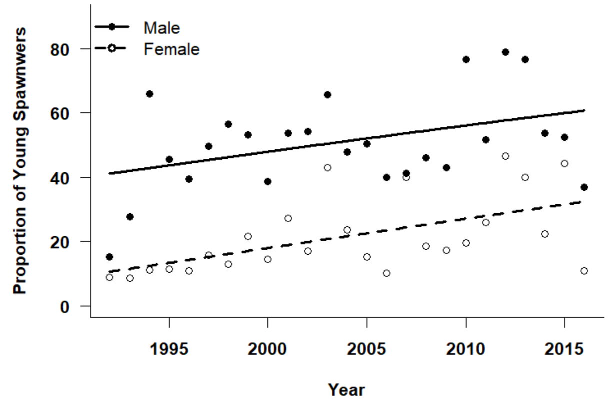


FIG. 9.14.2. Change in Chinook salmon (a) average fork length (mm) and (b) proportion of young spawners (%) on the Credit River, Mississauga, ON from 1992 to 2016. Female Chinook salmon are represented by the open circles and dashed linear line and males are closed circles with solid line.

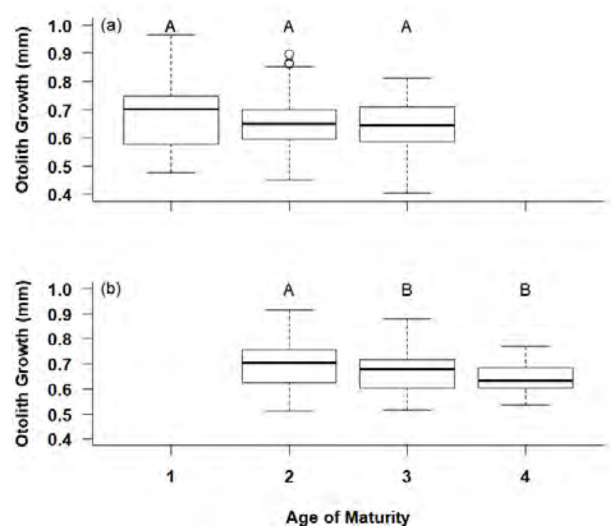


FIG. 9.14.3. First year otolith growth for (a) male and (b) female Chinook salmon spawning in the Credit River, Mississauga, ON from 2006 to 2016 relative to their subsequent age of maturity. Letters indicate significant differences in fork length between spawning ages as determined by post-hoc Tukey analysis ($p < 0.05$). Ages with the same letter indicate that they are not significantly different.

9.15 American Eel Acoustic Telemetry

L. Johnson and A. Mathers, Lake Ontario Management Unit and
S. Schlueter, U.S. Fish and Wildlife Service

The American Eel (*Anguilla rostrata*) naturally inhabits the upper St. Lawrence River (SLR) and Lake Ontario (LO) watersheds but have undergone substantial declines in abundance (see Section 8.3). Their decline has been attributed to many factors, however, one of the major issues identified for eel recovery is the need to increase escapement of mature eels from Lake Ontario during their migration to the spawning grounds in the North Atlantic Ocean. Currently, approximately 40% of the eels migrating downstream from Lake Ontario are killed in hydro generation turbines located in the SLR.

Two large hydro-electric generation facilities along the SLR, the Moses-Saunders Generating Station, (Cornwall, Ontario) and the Beauharnois Generating Station (Quebec) are barriers to downstream eel migration. To mitigate the eel mortality in turbines, Ontario Power Generation has developed a trap and transport program with local commercial fishermen where the eels are caught and trucked past the two hydro stations before being released downstream (see Section 8.3). In addition to the eel Trap and Transport program, over 6.2 million glass eels were translocated (stocked) from New Brunswick and Nova Scotia into the LO watershed between 2006 and 2010 in the hopes that they would grow to maturity in the LO / SLR system, then migrate out to spawn and some of their offspring would migrate back to the LO / SLR.

An acoustic telemetry study was initiated to gather information regarding eel movement during migration downstream to their spawning grounds with the goal of developing methods of guiding eels safely around dams. Queen's University, with assistance from LOMU, has established arrays of acoustic receivers in the Bay of Quinte. In addition, the USFWS has established an array at Iroquois Water Control Structure (IWCS, located in the upper SLR) and additional arrays have been established by the Province of Quebec and the Ocean Tracking Network at various locations downstream.

Since the fall of 2015, 345 eels collected by the Trap and Transport Program have been surgically implanted with acoustic tags and released (Table 9.15.1). Until 2018, all of the eels tagged were captured in the Bay of Quinte and

TABLE 9.15.1. Fate of acoustic tags implanted in American Eels during tagging sessions between fall of 2015 to spring of 2018. Note that all eels were captured for tagging in the Bay of Quinte, except those released at Mallorytown and Lake St. Francis which came from Lake St. Francis. Also, the fish released at Mallorytown or Lake St. Francis were not evaluated for "dead" tags and the Iroquois array was not present in 2015.

Tagging Session	Fall 2015	Spring 2016	Fall 2016	Spring 2017	Fall 2017	Spring 2018	Spring 2018	Spring 2018	Total
Release Location	Bay of Quinte	Bay of Quinte	Bay of Quinte	Bay of Quinte	Bay of Quinte	Bay of Quinte	Mallory-town	Lake St. Francis	All
# eels released	13	39	40	49	50	52	57	45	345
# "dead" tags	0	4	2	1	1	4	n/a	n/a	12
# eels detected in eastern Lake Ontario	13	39	40	49	50	52	0	n/a	243
# eels detected in western Lake Ontario	5	9	8	11	20	4	0	n/a	57
# eels detected at Iroquois	n/a	17	20	22	34	23	17	n/a	132
# eels detected in Quebec	7	10	15	17	19	16	8	17	109
# eels detected at OTN	1	0	5	3	4	0	0	0	13

released back into these waters. Analysis of a sample of eels collected from the Bay of Quinte showed that the majory of these fish originated from the OPG stocking conducted between 2006 and 2010. Of the 345 tagged eels 12 tags have shown no movememt and the eels likely died or shed their tags (Table 9.15.1). Of the eels tagged and released in the Bay of Quinte ("dead" tags excluded) during 2016 and 2017, 55% have been detected in the Iroquis Dam array, 36% detected in Quebec waters of the SLR and 7% detected on the Cabot Strait receiver array in the North Atlantic Ocean (between Cape Breton and Newfoundland) (Table 9.15.1). These results suggest that large stocked eels can be tagged with few mortalities and that many of these fish will migrate down the SLR system towards the spawning grounds in the North Atlantic Ocean. Work at IWCS has focused on VEMCO Positioning System (VPS) in order to determine if eels favour a particular path through the dam. Route of passage through the dam was quite variable at IWCS but overall the eels tended to avoid the western side (Canadian side) of of the dam (Fig. 9.15.1). The same eels are tracked by the Government of Quebec in a VPS array as they move past the Beauharnois Generating Station.

The objective of the 2018 tagging efforts was to examine differences in passage between stocked and naturally recruited eel populations. Tailwater surveys conducted below hydro dams in the SLR and monitoring of the silver eel fishery in the SLR estruary (section 8.3) suggest that historically eels left LO primarily in August through mid-September, much earlier than the passage of the stocked eels that we observed during previous years tracking.

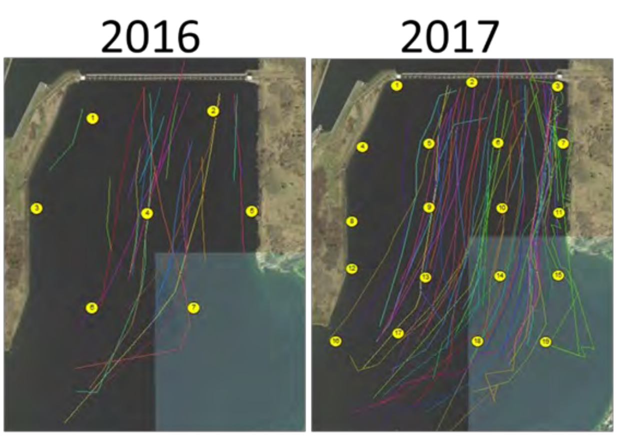


FIG. 9.15.1. Passage of American Eels migrating through the Iroquois Water Control Structure in the upper St. Lawrence River. Yellow symbols are locations of the acoustic receivers. Lines represent the tracks of individual tagged eels based on VPS analysis of the receiver data (https://vemco.com/products/vps/). Fig. from S. Schlueter and J. Ecret (USFWS). The tracks of the eels detected in 2018 were not available at the time of publication of this report.

Vemco V13 69 kHz internal acoustic transmitters were surgically implanted into one hundred and fifty-four large eels captured in the spring of 2018 through the Trap and Transport Program, 52 from the Bay of Quinte (considered stocked eels) and 102 from Lake St. Francis (considered naturally recruited eels). Some of the Lake St. Francis fish were released back into Lake St. Francis, while others were moved upstream of IWCS and released at Mallorytown Landing dam (Fig. 9.15.2).

Tagged eels from the Bay of Quinte, although smaller in both weight and length, were more mature. When the American Eel starts to mature, the pectoral fins grow and eyes get larger in order to help make the mirgation to the Sargasso Sea. The eels from the Bay of Quinte (stocked) had higher pectoral fin index and occular index than the Lake Saint Francis (naturally recuited) eels (Fig. 9.15.3).

After first dections at IWCS most eels (both stocked and natural recruits) moved quickly through the array with 87% of eels passing through the array in less than 120 mins (2 hours). Since the overall goal of the acoustic telemertry study is to inform the creation of a guidance system for migratory eels, further analysis was completed only on eel that passed the array in less that 120 mins. Timing of movement of eels through the Iroquois array differed between the stocked and natural recruits. Eels released at Mallorytown (assumed to be natural recruits) started passing through the array as early as May (week 21) and the last detection event occurred in September (week 37) with the peak number of detections occuring in July and August (Fig. 9.15.4). Bay of Quinte eels (presumed to be stocked) started passing the array in September (week 37), and dectections didn't cease until early December with the peak occuring during the week of October 22nd. The seasonality of passage at IWCS of eels originating in the Bay of Quinte

FIG. 9.15.2. Eel capture locations, eel release locations and dams identified in this report.

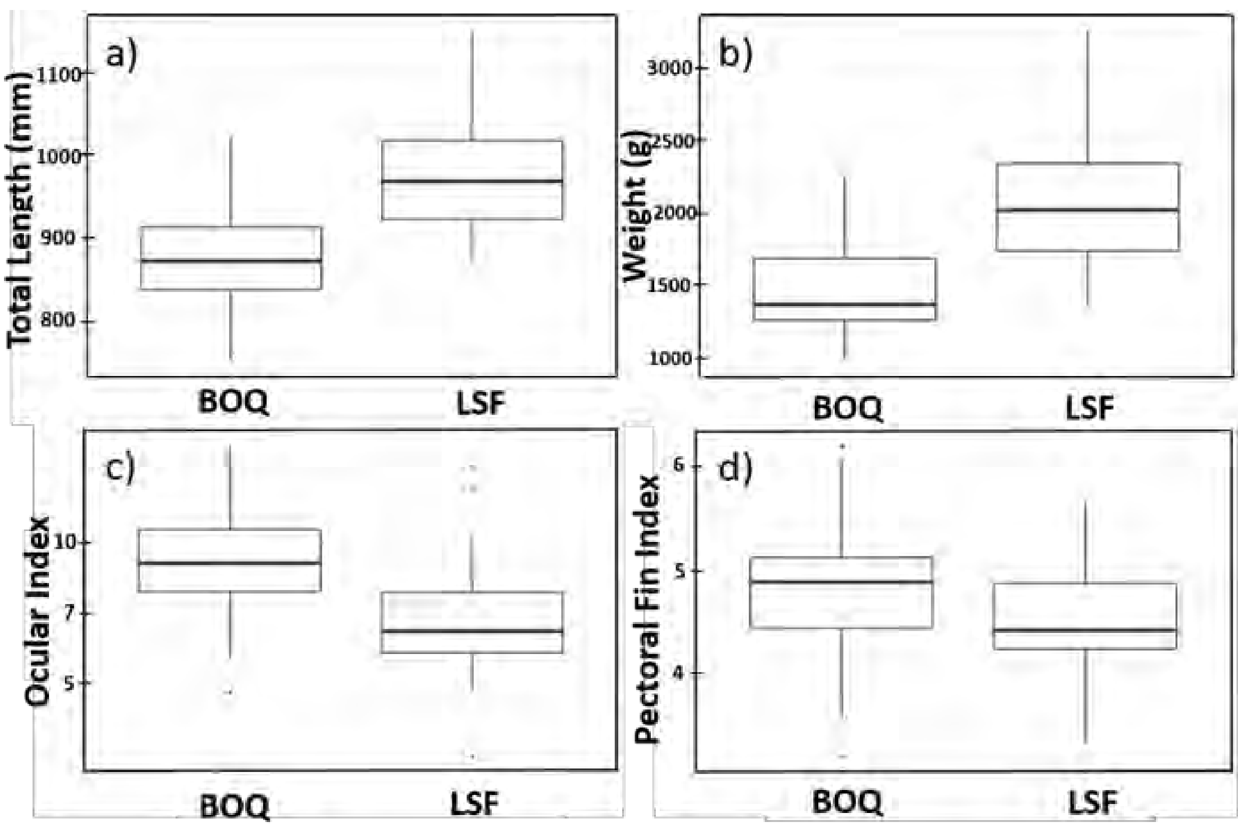


FIG. 9.15.3. Differences in total length, weight, ocular index and pectoral fin index between eels collected during the acoustic tagging process from the Bay of Quinte (stocked) and Lake St. Francis (natural recruits).

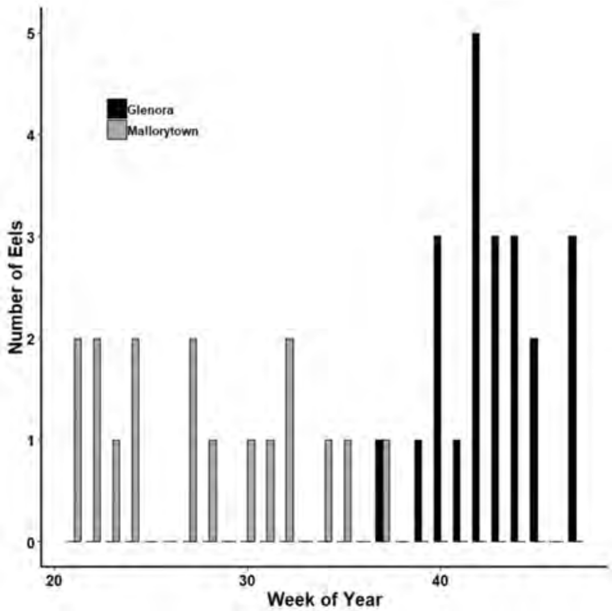


FIG. 9.15.4. Number of eels per week in 2018 at the Iroquois Water Control Structure on the upper St. Lawrence River. The release locations refer to the different source of eels that were tagged. Eels released at Glenora are stocked individuals. Eels released at Mallorytown are part of the natural migrant population.

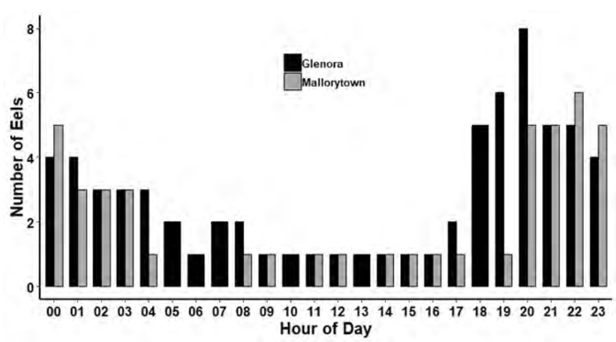


FIG. 9.15.5. Number of eels detected at each hour of the day during 2018 at the Iroquois Water Control Structure on the upper St. Lawrence River. Glenora eels are stocked individuals and Mallorytown eels are part of the naturalized population.

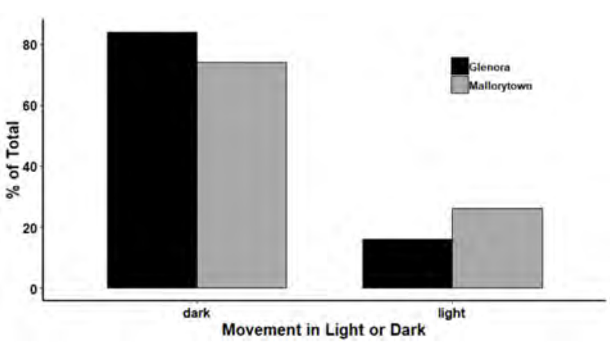


FIG. 9.15.6. Number of eels moving in the dark vs. light at the Iroquois Water Control Structure during 2018.

during 2018 is very similar to the pattern observed during 2016 and 2017.

The hour of movement through the IWCS array seemed to be similar for both the stocked and natural recuits. Most movement occurred between 20:00 and 04:00 (Fig. 9.15.5). Additionally, 80% of eels detections were in darkness for both stocked and natural recuits (Fig. 9.15.6) which is defined as the time between nautical dusk and nautical dawn.

Of the 10 depth sensor tags deployed in 2017, 6 tags passed our array during 2017 and one tag passed during 2018. These fish exhibited the vertical searching behavior as described previously in the literature (Fig. 9.15.7).

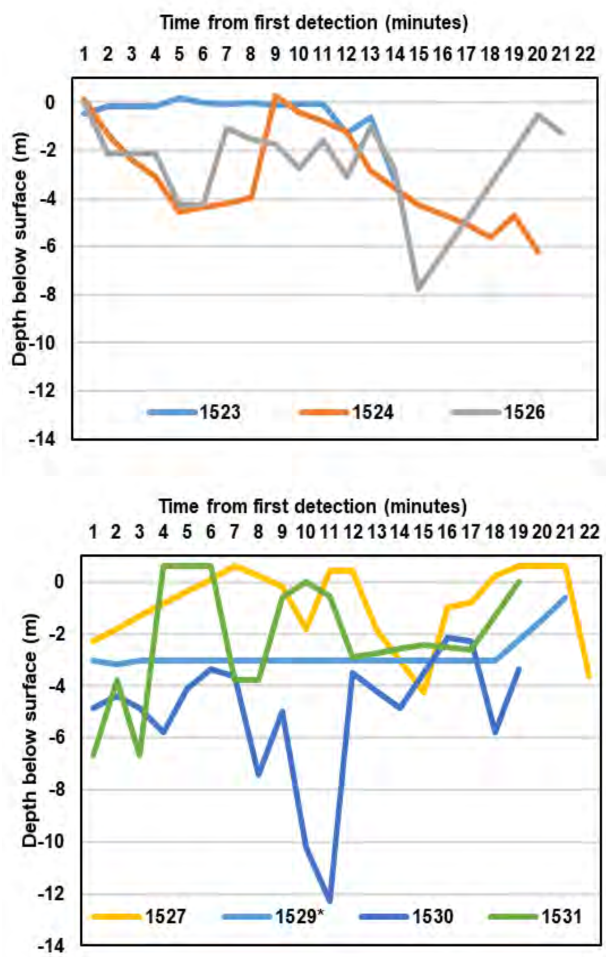


FIG. 9.15.7. Depth of tagged eels detected in the IWCS array during 2017 and 2018. Note that tag 1529 detected in the array for almost 13-days, so the last 20 minutes of detections is displayed here.

9.16. Migration and Spatial Ecology of Bay of Quinte-Eastern Lake Ontario Walleye

E. Brown[1], C. W. Elliott[2], J. A. Hoyle[1] and B. L. Tufts[2]
Lake Ontario Management Unit[1]; Queen's University[2]

Walleye are the dominant piscivorous fish in the Bay of Quinte-eastern Lake Ontario nearshore waters and are known to be highly migratory. Historical mark-recapture studies and age-specific geographical and seasonal distributions suggest that movements are related to spawning location, temperature regimes, and foraging opportunities. This Walleye population supports important recreational, commercial, and First Nations fisheries. In recent years, an increase in anglers targeting "trophy" Walleye has been observed in eastern Lake Ontario (see Section 2.3 and Section 7.5).

The goal of this multi-year acoustic telemetry project is to describe Bay of Quinte-eastern Lake Ontario Walleye movement at a finer scale than is currently understood, and subsequently, to better understand the mechanisms which influence aspects of Walleye life history. Within the first two years of this project, we describe the annual distribution and movement patterns of large Bay of Quinte Walleye tagged at time of spawning and highlight areas of seasonal aggregation. Further, we begin to examine the hypothesis that those fish observed in the "trophy" Walleye fishery in eastern Lake Ontario are part of the Bay of Quinte migratory Walleye population. This project is part a Walleye acoustic telemetry partnership between Queen's University and the Lake Ontario Management Unit (LOMU) (e.g. see Section 9.17).

One hundred and twenty-one large Walleye (> 2.5 lbs) were surgically implanted with acoustic transmitters between 2017 and 2018. Biological measurements were collected, external identification tags were applied, and fish were released near their capture location. A summary of capture and tagging events can be found in Table 9.16.1. Detection data was collected using a well-established array of acoustic receivers in Lake Ontario and the GLATOS network (see Section 9.5; Fig. 9.5.1). In this report, we examine individual detection histories for those large Walleye tagged in the Bay of Quinte at the time of spawning and report their annual distribution by month (Nov 2017 – Oct 2018; Fig. 9.16.1). Detection histories prior to Nov 2017 are reported in the 2017 Annual Report of the Lake Ontario Management Unit. Detections of Walleye tagged in Kingston Basin and New York are not reported at this time.

Throughout the months of Oct - Dec, Walleye moved back into the Bay of Quinte where they resided over winter. After spawning, Walleye moved towards eastern Lake Ontario (April - May). The majority (88%) of Walleye left the Bay of Quinte within one month of being tagged, passing through the gap between Prince Edward County and Amherst Island. Twenty-five percent migrated to New York waters within 1-2 weeks of leaving the bay (May - June). Walleye were detected throughout eastern Lake Ontario during the late-spring and summer, with some areas of aggregation identified: 65% detected at Melville shoal between June and July; 81% detected near Long Point between August and September. Some individuals traveled expansive distances. Of note, one Walleye was detected at the Iroquois Dam (St. Lawrence River) and two travelled to western Lake Ontario.

Queen's University and LOMU will continue acoustic tagging efforts and receiver retrievals in 2019. Additional years of detection information paired with information from LOMU's ongoing assessment program is expected to provide a compressive understanding of Walleye spatial ecology in Lake Ontario and support the management of this important population.

TABLE 9.16.1: Summary of Walleye (> 2.5 lbs.) acoustic telemetry tagging events (V16 69 kHz VEMCO internal acoustic transmitters) and biological data collection in eastern Lake Ontario, 2017-18.

Capture Location	Date Tagged	Capture Method	Average Length (in)	Average Weight (lbs)	Number Tagged M	Number Tagged F	Number Tagged U	*Total*
Big Bay, Bay of Quinte	2017-Apr	Trap Net	24.11	5.38	5	5	-	*10*
Trumpour Point, Bay of Quinte	2017-Apr	Trap Net	27.08	7.77	5	5	-	*10*
Trent River, Bay of Quinte	2017-May	Electrofishing	24.51	5.58	3	2	1	*6*
Timber Island, Kingston Basin	2017-Aug	Angling	27.57	8.44	-	-	10	*10*
Black River, New York	2018-Apr	Trap Net	27.90	9.80	1	9	-	*10*
Trent River, Bay of Quinte	2018-Apr	Electrofishing	26.28	7.22	11	11	-	*22*
Napanee River, Bay of Quinte	2018-Apr	Electrofishing	24.92	5.69	11	10	-	*21*
Melville Shoal, Kingston Basin	2018-Jun	Gill Net	26.17	8.04	-	-	20	*20*
Timber Island, Kingston Basin	2018-Aug	Gill Net	25.87	7.23	-	-	12	*12*
			Average		*Total*			
			26.05	*7.24*	*36*	*42*	*43*	***121***

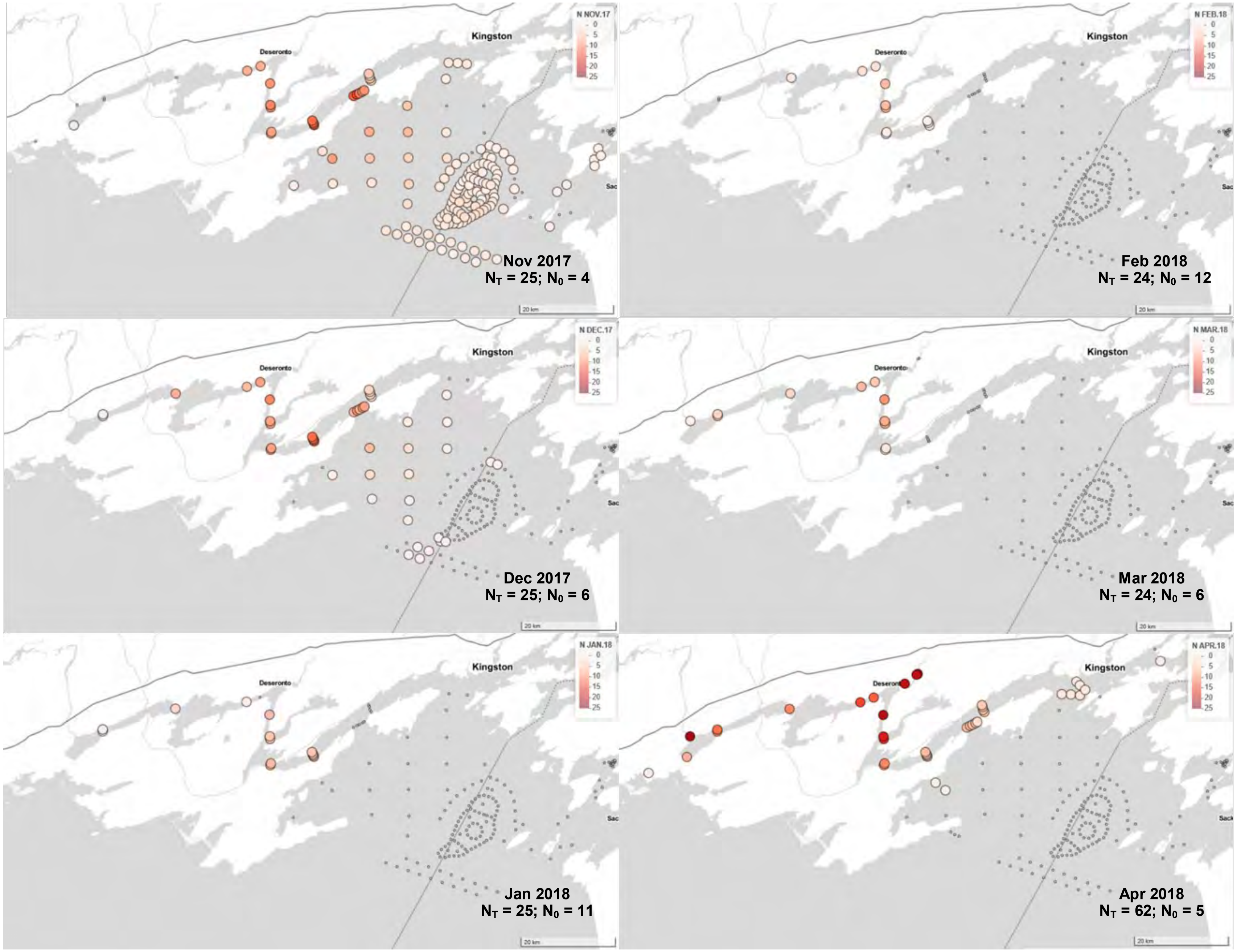


FIG. 9.16.1 Overview of acoustic receiver locations and detections in the Bay of Quinte-eastern Lake Ontario, separated by month (November 2017 - October 2018). The number of tagged fish detected (N) at each receiver is visualized by colour saturation. Smaller circles with no colour indicate receivers, which were active and were downloaded at the time of this report, but for which no fish were detected. The number of fish in the tagged population during each month is denoted as N_T; this excludes the fish tagged in Kingston Basin and New York. The number of fish that were part of the defined tagged population (N_T) but which were not detected by any receiver during each time period is also displayed (N_0).

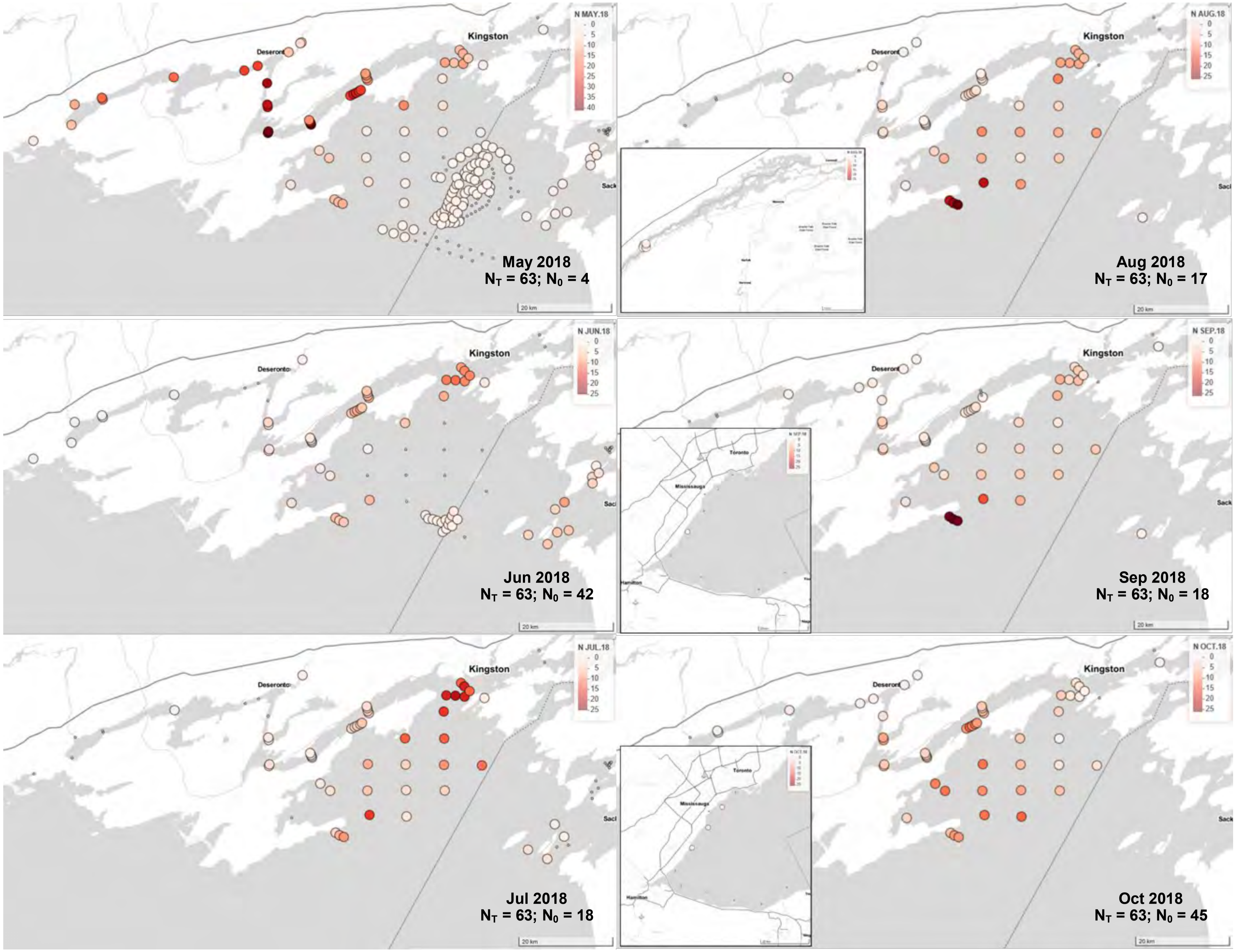


FIG. 9.16.1 *continued*. Overview of acoustic receiver locations and detections in the Bay of Quinte-eastern Lake Ontario, separated by month (November 2017 - October 2018). The number of tagged fish detected (N) at each receiver is visualized by colour saturation. Smaller circles with no colour indicate receivers, which were active and were downloaded at the time of this report, but for which no fish were detected. The number of fish in the tagged population during each month is denoted as N_T; this excludes the fish tagged in Kingston Basin and New York. The number of fish that were part of the defined tagged population (N_T) but which were not detected by any receiver during each time period is also displayed (N_0).

9.17 Spatial Ecology of Juvenile Bay of Quinte Walleye

C. W. Elliott[1], E. Brown[2], J. A. Hoyle[2] and B. L. Tufts[1]
Queen's University[1]; Lake Ontario Management Unit[2]

Adult Walleye (*Sander vitreus*) are known to be highly migratory in the Bay of Quinte and eastern Lake Ontario. In the spring, adults utilize the bay to spawn before migrating back out to eastern Lake Ontario for the summer. Juveniles (typically less than age-5) are thought to be resident to the Bay of Quinte, and previous studies have shown they make use of different regions of the bay throughout the year. The aim of this project is to collect more detailed insights into the seasonal movements and distribution of juvenile Walleye using acoustic telemetry. The multi-year battery life of the acoustic transmitters will also provide understanding into the transition to a migratory lifestyle for these non-migratory juveniles. This data collection will utilize the now well-established array of acoustic receivers maintained by Queen's University, OMNRF, and USFWS in the Bay of Quinte-eastern Lake Ontario (see Section 9.5; Fig. 9.5.1).

In April of 2018, 12 smaller (< 2 lbs) male Walleye were surgically implanted with acoustic transmitters. Fish were captured using boat electrofishing in the Trent and Napanee Rivers, and six Walleye were tagged in each river. The acoustic tags used were Vemco V13 69 kHz acoustic transmitters, which provide five years of battery life. Fish had length and weight recorded, aging structures collected and were externally tagged with an orange loop tag. In July, an additional eight juvenile Walleye were captured angling in Hay Bay. These fish were tagged and processed similarly to those tagged in the spring and were again considered smaller, juvenile fish (< 3 lbs). In September, another seven juvenile Walleye (< 3½ lbs) were caught using trapnets in the Upper Bay of Quinte. The fish were again tagged and processed before being released back into the waterbody. All tagged Walleye were released in the same general vicinity to where they were captured. A summary of capture and tagging events can be found in Table 9.17.1.

The juveniles from the spring tagging event were concentrated in the upper bay for much of the spring and moved into the lower bay by mid-summer (Fig. 9.17.1). This dispersal from the upper bay was much slower for the juveniles than the acoustically tagged adult Walleye (Section 9.16). One of the juvenile Walleye was removed from the tagged population through recreational angling in the late spring. During the summer, some Walleye remained in the upper bay, however, the highest concentrations were observed in the lower bay. While seven of the Walleye never left the Bay of Quinte, four of the juveniles moved into the eastern basin during mid-summer and into the fall. This transition into the eastern basin saw juveniles travel as far as Howe Island in the St. Lawrence River, and False Duck Island near the tip of Long Point. Until the end of October, none of the juveniles tagged in July in Hay Bay had moved out of Hay Bay, and the juveniles tagged in September the upper bay had not moved out of the area where they were tagged.

Acoustic tagging efforts of juvenile Walleye will continue in 2019 as part of the acoustic telemetry partnership between Queen's University and LOMU. Tagging is planned to take place in the spring and will be mainly focused on the Trent and Napanee River. The target Walleye for this tagging will again be age-4 and younger. The size tagged in the rivers during the spring of 2018 exhibited an interesting combination of migration strategies that warrants further study. A larger dataset from these younger fish should provide insights into how juvenile Walleye utilize the Bay of Quinte seasonally and the factors driving their change to a migratory lifestyle into eastern Lake Ontario.

TABLE 9.17.1. Summary of juvenile Walleye acoustic telemetry tagging events (V13 69 kHz VEMCO internal acoustic transmitters) and biological data collection in the Bay of Quinte during 2018.

Capture Location	Date Tagged	Capture Method	Average Length (in)	Average Weight (lbs)	Number Tagged			*Total*
					M	F	U	
Napanee River, Bay of Quinte	2018-Apr	Electrofishing	16.73	1.46	6	-	-	*6*
Trent River, Bay of Quinte	2018-Apr	Electrofishing	16.14	1.46	6	-	-	*6*
Hay Bay, Bay of Quinte	2018-July	Angling	17.08	1.71	-	-	8	*8*
Upper Bay, Bay of Quinte	2018-Sept	Trap Net	18.93	2.28	-	-	7	*7*
			Average		*Total*			
			17.22	*1.73*	*12*	*-*	*15*	*27*

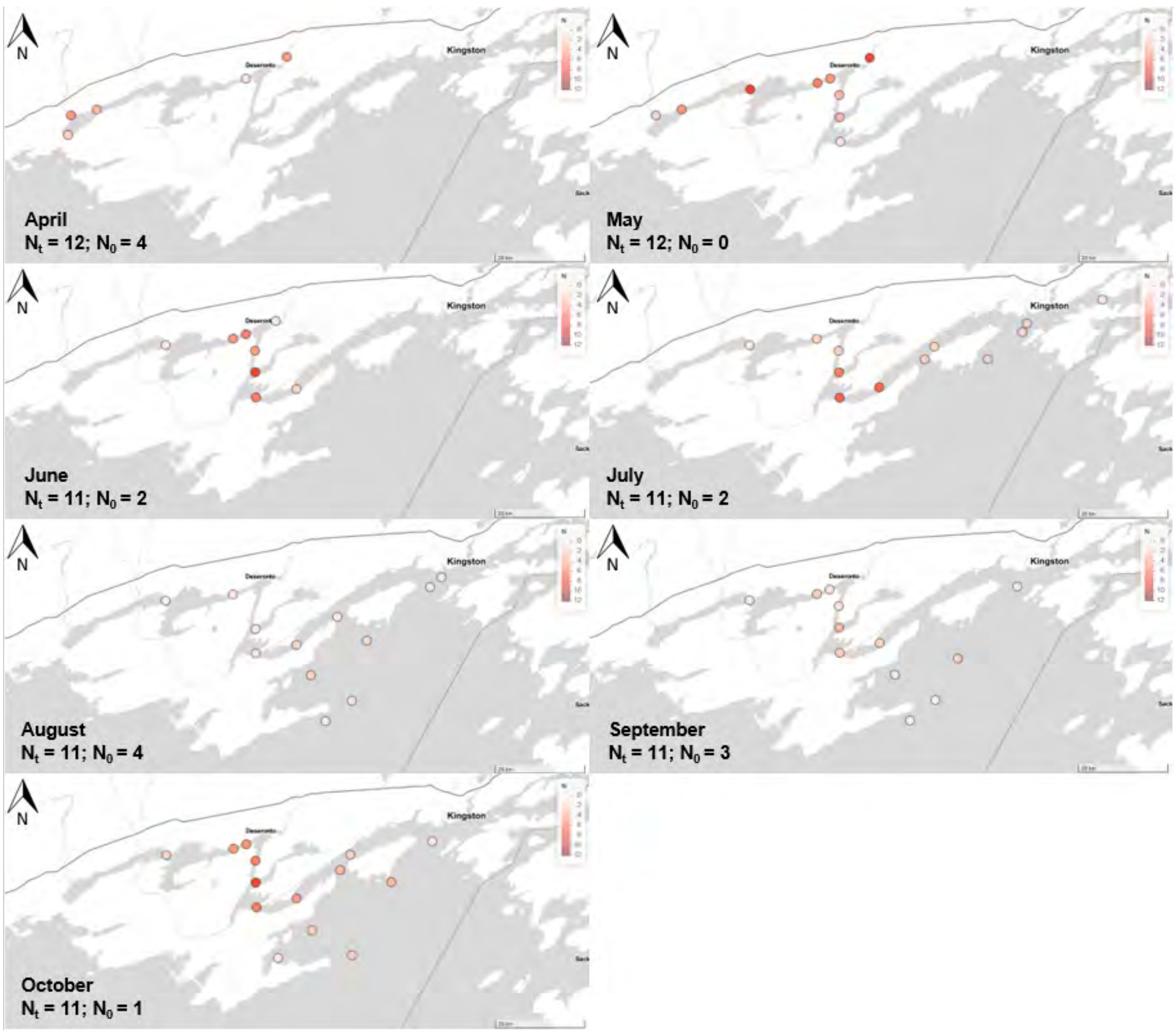


FIG. 9.17.1. Monthly detections of juvenile Walleye at receiver stations in 2018, where the number of unique Walleye detected during that month is represented by the colour saturation of the station. N_t denotes the total number of tagged juvenile Walleye in the tagged population for each month, while N_0 denotes the number of juvenile Walleye in the tagged population which were not detected on any receivers during that month. The Walleye tagged in Hay Bay and the upper bay in September are not depicted in this figure and only the Eastern Lake Ontario Multi-Species Array (ELOMA) receiver network was used to report detections.

9.18 Bay of Quinte – Eastern Lake Ontario Coregonus Acoustic Telemetry

S. J. H. Beech[1], E. Brown[2], J. A. Hoyle[2] and B. L. Tufts[1]
Queen's University[1]; Lake Ontario Management Unit[2]

Lake Whitefish (*Coregonus clupeaformis*) and Cisco (*Coregonus artedi*) were historically abundant cold-water fish species in Lake Ontario. Both species have declined due to overfishing, habitat degradation and invasive species introductions. Decreased body condition and reproductive success of the commercially important Lake Whitefish since the late 1990's has emphasized the need to better understand the spatial ecology of this population. Using acoustic telemetry, this project is monitoring seasonal migration patterns of Lake Whitefish in the Bay of Quinte and eastern basin of Lake Ontario. The goal of this project is to better understand patterns of movement in this population with a focus on spawning areas and geographic distribution. There has also been increased effort in Lake Ontario Cisco restoration in recent years. A parallel project is also using acoustic telemetry to monitor Cisco movements to better understand geographic distribution and possible spawning areas for this species. The Cisco project has limited data at this time, so this report will focus on Lake Whitefish.

A total of 57 Lake Whitefish have been tagged with acoustic transmitters between 2016 and 2018. In April and November of 2016 and 2017, 29 Lake Whitefish were captured using trap netting at various locations in the Bay of Quinte (Trumpour's Point, Sherman's Point, Big Bay and Northeast Big Island). Individuals that exceeded 400 mm in length were surgically implanted with Vemco V13 69 kHz acoustic transmitters that have a 2-year battery life. Individuals that exceeded 1200 g in weight were implanted with larger V16 69 kHz acoustic transmitters with a 5-year battery life. An additional 28 Lake Whitefish were captured in October and November of 2018 and were all tagged with Vemco V16 69 kHz acoustic transmitters. Eleven of these fish were captured around Northeast Big Island in the Bay of Quinte and the remaining 17 were tagged the south side of Prince Edward County. In April of 2016, 23 Cisco were captured at Trumpour's point in the Bay of Quinte and implanted with V9 69 kHz acoustic transmitters. A summary of Lake Whitefish capture events and biological information can be found in Table 9.18.1. A network of acoustic receivers has been deployed by Queen's University, OMNRF and USFWS throughout the Bay of Quinte and eastern Lake Ontario (see Section 9.5; Fig. 9.5.1). The detection data collected by these receivers are used to interpret fish movements over space and time.

TABLE 9.18.1. Summary of Lake Whitefish acoustic telemetry tagging events (V13 and V16 69 kHz VEMCO internal acoustic transmitters) and biological data collection in eastern Lake Ontario 2018.

Capture Location	Date Tagged	Capture Method	Average Length (in)	Average Weight (lbs)	Number Tagged M	F	U	*Total*
Trumpour's Point, Bay of Quinte	2016-Apr	Trap Net	22.14	-	-	-	5	*5*
Sherman's Point, Bay of Quinte	2016-Apr	Trap Net	19.29	-	-	-	1	*1*
Northeast Big Island, Bay of Quinte	2016-Nov	Trap Net	21.44	-	2	2	-	*4*
Big Bay, Bay of Quinte	2017-Apr	Trap Net	20.94	2.86	-	-	2	*2*
Trumpour's Point, Bay of Quinte	2017-Apr	Trap Net	21.54	3.38	-	-	4	*4*
Northeast Big Island, Bay of Quinte	2017-Nov	Trap Net	20.02	2.46	-	-	13	*13*
Northeast Big Island, Bay of Quinte	2018-Oct	Trap Net	21.67	-	2	4	5	*11*
Big Sand Bay, Lake Ontario	2018-Nov	Gill Net	20.63	3.75	1	-	-	*1*
Gravelly Point, Lake Ontario	2018-Nov	Gill Net	18.59	2.62	12	4	-	*16*
			Average		*Total*			
			20.70	*3.01*	*17*	*10*	*30*	*57*

Seasonal movements of tagged Lake Whitefish were analyzed and the spatial distribution results are shown in Fig. 9.18.1. During the summer seasons (June 21st - September 21st) tagged Lake Whitefish primarily occupied the lower bay with some individuals moving into the eastern basin. In the fall (September 22nd - December 20th) the tagged Lake Whitefish migrated into the middle and upper parts of the bay to spawn. Many of these individuals quickly left the bay later in the fall season (likely after spawning). The tagged Whitefish occupied several different areas during the winter (December 21st - March 19th). Some Lake Whitefish remained in the middle and upper parts of the bay while others migrated into the lower bay and eastern basin. In the spring (March 21st - June 20th) the tagged Lake Whitefish that overwintered in the middle/upper bay began migrating towards the lower bay with some moving into the eastern basin prior to summer. The data from Lake Whitefish tagged in 2018 will not be available until the receivers are downloaded in the spring of 2019 and will be analyzed in the future.

This project will continue to monitor the movements and habitat use of Lake Whitefish and Cisco in order to better understand the seasonal geographic distribution and spawning areas of these populations. Thus far, the tag detections come from the population of Lake Whitefish individuals that spawn in the Bay of Quinte. Lake Whitefish recently tagged during spawning off southern Prince Edward County should provide interesting information about the differences in movements between these two spawning stocks.

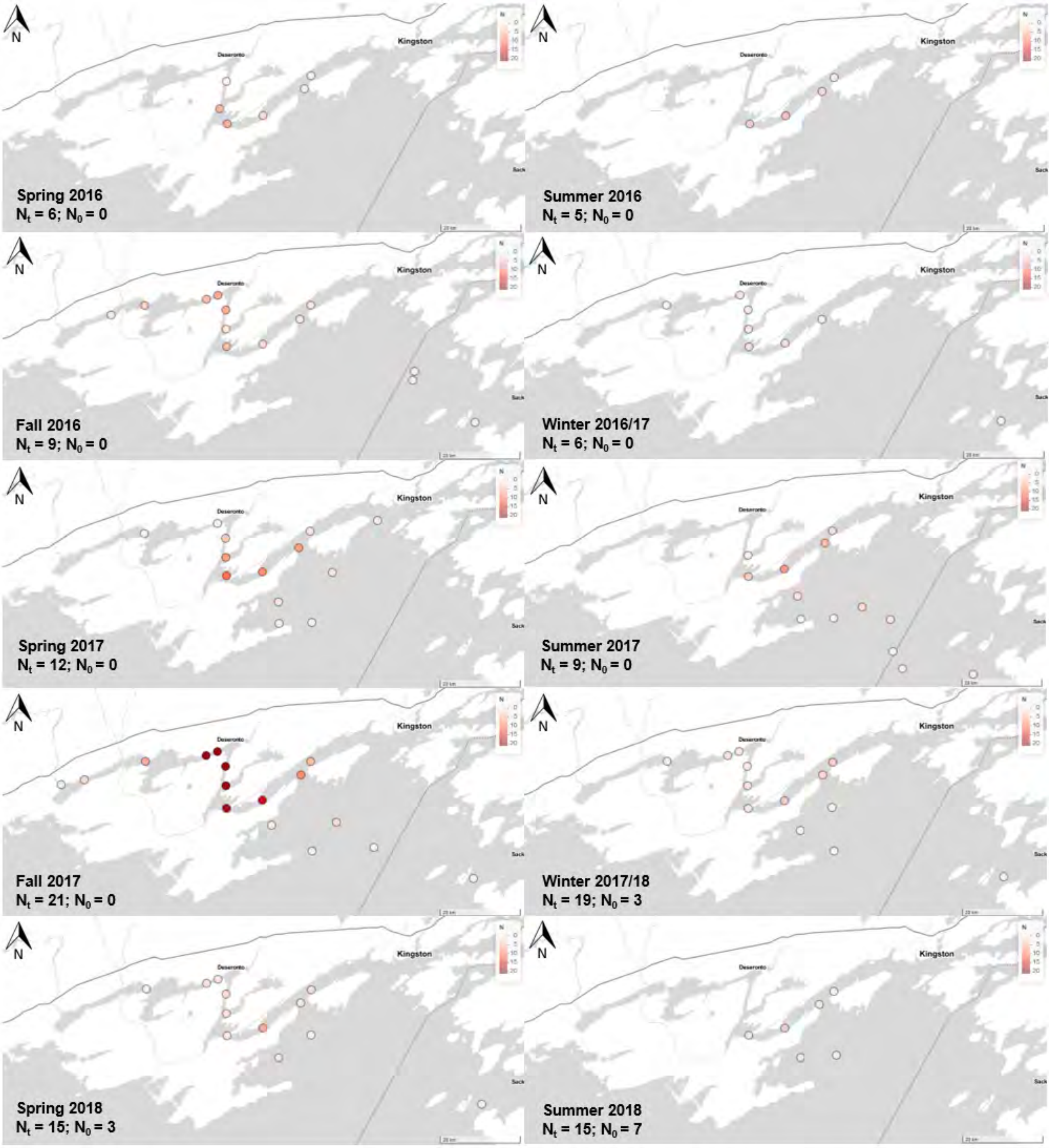


FIG. 9.18.1. Seasonal detections of Lake Whitefish are shown from Spring 2016 through Summer 2018. Colour saturation at a station represents the number of unique Whitefish detected. Total number of Whitefish in the tagged population for each season is N_t and the number of tagged Whitefish that were not detected in that season is N_0. Locations of deployed receivers are outlined in Section 9.5 and data from the Lake Ontario Deepwater Cisco array (LODWC) was not yet available for summer 2018 at the time of this report.

10. Partnerships

10.1 Cooperative Science and Monitoring Initiative

The Cooperative Science and Monitoring Initiative (CSMI) is a process which encourages Great Lakes focussed agencies to work together to conduct research and monitoring to address binational science priorities. This initiative comes from the bi-national Great Lakes Water Quality Agreement (GLWQA) and is also referenced within the Canada-Ontario Agreement on Great Lakes Water Quality and Ecosystem Health (COA). CSMI follows a 5-year cycle where, in a given year, bi-national collaborative science teams on each Great Lake focus on a respective activity including: priority setting, planning, coordinated field work, data analysis and reporting findings. Through the CSMI process, partners bring together resources and leverage support (e.g. vessel time, laboratory analysis) to answer questions and gather information at wider geographic extents and of greater complexity than is possible through routine programs.

In 2018, researchers from several agencies, academic institutions and organizations completed an extensive cooperative field program of monitoring and research on Lake Ontario intended to build on results from CSMI in 2013 and address the following science priorities identified by the Lake Ontario Partnership (LaMP) in 2017:

- Characterize Nutrient Concentrations & Loadings
- Improve our Understanding of Nearshore Nutrient Related Problems
- Evaluate the Status of the Aquatic Food Web
- Improve our Understanding of Fish Dynamics
- Characterize Critical and Emerging Pollutants
- Evaluate coastal Wetland Status

Bi-national CSMI science activities in 2018 were wide ranging and examples included monitoring of nutrient loads to Lake Ontario from tributaries and from Lake Erie via the Niagara River; diver surveys of nearshore benthic algae growth; remote sensing of coastal wetlands; a continuation of the long-term Lake Ontario Lower Trophic Level Assessment; and an analysis of contaminants in young-of-year fish.

Staff from the Lake Ontario Management Unit (LOMU) and the Aquatic Research and Monitoring Section (ARMS) worked collaboratively with many partners to complete CSMI projects in 2018.

LOMU and Queen's University are working in partnership to track the movements of *Coregonus* in the Bay of Quinte – Eastern Lake Ontario (see Section 9.18). In 2018, LOMU collaborated with University of Windsor, Queen's University and a local Commercial Fisher to acquire and deploy 30 VEMCO acoustic transmitters (20 V13 and 10 V9) in Cisco captured at the time of spawn in Big Bay, Bay of Quinte. Information gathered over the next two years will help describe the distribution of the Bay of Quinte Cisco stock and provide preliminary insight into spawning activities.

With the help of federal, provincial, and state agencies, as well as several academic partners (both in Canada and the US), ARMS led a project to investigate fish community foodweb dynamics in an effort to better understand the production potential of the Lake Ontario fish community, the impact that invasive species may have on the fish community and identify potential challenges for native species restoration. Using ecological tracers such as stable isotopes, fatty acids, mercury, and thiaminase collected from fish and invertebrate tissues provided by LOMU and other collaborators, ARMS will compare Lake Ontario's present day foodweb with data collected in previous CSMI years (e.g., 2013, 2008), as well as to other Great Lakes, to identify similarities and differences across the various fish communities, and learn more about what they may mean for Lake Ontario's diverse fish community (see Section 9.12 for more information).

LOMU also completed an extensive Spatial Pelagic Assessment Project in collaboration with USEPA, USGS, USFWS, NYSDEC, OMNRF, DFO, Queen's University and Cornell University to understand how native prey fish are distributed spatially within Lake Ontario. Information gathered through this work will assist in the interpretation of LOMU's existing prey fish surveys (Sections 7.8 and 7.9) and support native fish restoration (section 8). The project included three distinct field components.

A bi-national, multi-agency larval fish survey was conducted across Lake Ontario between April 2nd and May 14th. LOMU conducted 363 tows throughout the Bay of Quinte and the Kingston Basin (Fig. 10.1.1) out of a total of 1,240 tows conducted across the lake. Larval fish identification is being conducted by the USGS Lake Ontario Biological Station staff (Oswego, NY) and is supporting a graduate student project at Cornell University (Ithaca, NY).

A pelagic survey that included trawling and acoustic transects was conducted between September 10th and 18th throughout the Bay of Quinte, Kingston Basin and eastern portion Lake Ontario in US and Canadian waters (Fig. 10.1.2). Acoustic data was collected to determine fish abundance and midwater trawl catches will be used to apportion the acoustic abundance estimates to various species. The survey sampled areas where Cisco were suspected to be staging (Bay of Quinte and Mexico Bay, NY); Bloater stocking areas (Charity Trench, NY) as well as cross-lake transects to align with the July Pelagic Survey (Section 1.6) and USEPA acoustic transects for Mysids.

Throughout the fall LOMU conducted fish community sampling in the lower Bay of Quinte (Adolphus Reach). This is a unique transition area between the shallow Upper Bay of Quinte and the Kingston Basin and includes one of the few sites (Conway) where juvenile Cisco and Lake Whitefish are regularly caught by assessment programs. A multi-gear sampling approach was undertaken to gain a better understanding of the fish community and its distribution. Hydroacoustics and midwater trawling were conducted at night to target pelagic prey fish species (Fig. 10.1.3). An autonomous submersible echosounder was also deployed to observe daily vertical migration patterns of fish and invertebrates. Bottom trawling was conducted at the traditional Conway trawl site as well as several new sites throughout Adolphus Reach (Fig. 10.1.4). Gill netting was also conducted using the North American Standard Index Gill Nets throughout the Bay of Quinte to sample the larger fish species and areas that could not be sampled using trawl gear (Fig. 10.1.5). The gill net protocol was conducted simultaneously with US agencies (NYSDEC, USGS, USFWS, Cornell University) working in other embayments throughout the eastern and southern portion of

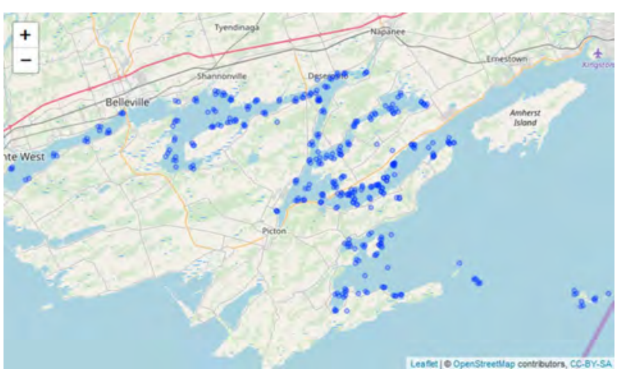


FIG. 10.1.1. Geographical extent of larval sampling throughout the Bay of Quinte and Kingston Basin conducted between April 19th and May 11th, 2018.

FIG. 10.1.2. Acoustic transects (grey lines) and midwater trawling (red circles) were conducted between September 10th and 18th, 2018 targeting pre-spawn Cisco, Bloater stocking areas and cross-lake transects.

FIG 10.1.3. Hydroacoustic cruise track (in grey) and midwater trawl sites (red dots) conducted between October 22nd to 26th, 2018 targeting prey fish species abundance and distribution throughout Adolphus Reach.

Lake Ontario to determine relative abundance of Cisco throughout the Lake.

Initial observations from Lake Ontario's CSMI 2018 will be presented, and collaborative reporting will be planned, at an upcoming Data Synthesis Workshop to be held in the late spring of 2019 at the State University College in Buffalo NY.

OMNRF's extensive contributions to binational CSMI projects in 2018 relied on the diligent work of the field operations team and administrative staff. These projects were carried out with provincial funding to implement OMNRF priorities under the Canada-Ontario Agreement on Great Lakes Water Quality and

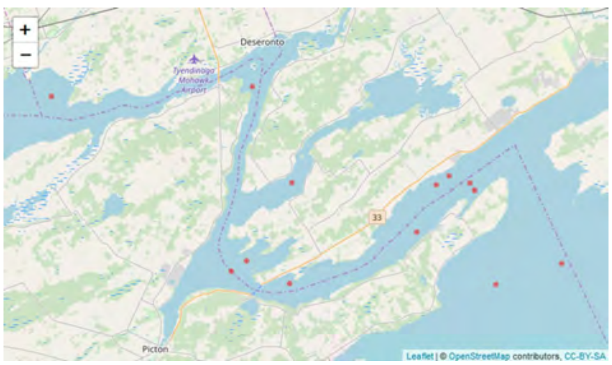


FIG. 10.1.4. Bottom trawl tow sites (red dots) conducted between October 31st and November 2nd. Tows were conducted using the 3/4 Western Poly Trawl ("Bay Trawl") used in Fish Community Index Trawling and sampled several of the same index sites but conducted much later in the season. Additionally, two Kingston Basin Sites were sampled which have historically only been sampled with the 3/4 Yankee trawl ("Lake Trawl") to assess the feasibility of using the Western Trawl, which has specialized foot gear that may reduce large Dressenid mussel catches in the Kingston Basin.

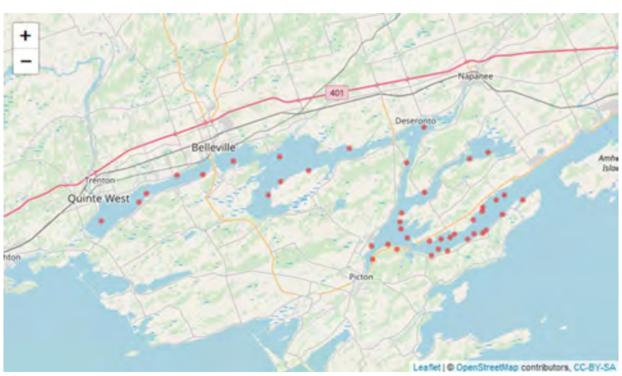


FIG. 10.1.5. Gill net locations sampled with North American Standard Index Gill Nets between November 5th and 15th.

10.2 Walleye Spawn Collection

E. Brown and J.A. Hoyle, Lake Ontario Management Unit

In April 2018 the Lake Ontario Management Unit (LOMU) worked in conjunction with MNRF's White Lake Fish Culture Station (FCS) to collect Bay of Quinte Walleye gametes. Similar projects were conducted in spring 2013 - 2017. In 2018, White Lake FCS had a target of eight million eggs and 40 families.

Walleye egg collection occurred April 3 - 6, 2018 on the Trent River below Lock #1. Boat electrofishing was used to target Walleye staging to spawn. Depths fished ranged from 0.5 - 2 m and water temperature averaged 2.9 ^{o}C. Walleye, in spawning condition, were brought to a holding and recovery pen at the mouth of the Trent River prior to spawn collection. The average fork length of Walleye selected for egg collection was 677 mm (560 - 805 mm) and 582 mm (470 - 680 mm) for females and males, respectively. Approximately 8.6 million eggs were collected from 34 families and transferred to White Lake FCS.

Walleye gametes collected in 2018 will be used to supply walleye fingerlings for stocking in inland lakes. The 2018 spawn collection will also provide wild gametes for restoration stocking of Walleye summer fingerlings in Hamilton Harbour (see Section 6.1 and 7.5).

Acoustic Telemetry Studies

Twenty-Eight Walleye were captured post spawn collection activities on the Trent River and were equipped with acoustic telemetry transmitters. These fish will be tracked for several years by acoustic receivers in place in the Bay of Quinte and eastern Lake Ontario. Twenty-seven additional Walleye were equipped with acoustic telemetry transmitters in the Napanee River in April - May using the same electrofishing methods (see Section 9.16 and 9.17).

10.3 Observations of Aquatic Invasive Species in Lake Ontario

N. J. Jakobi and L. Johnson, Lake Ontario Management Unit
K. Wozney, Aquatic Biodiversity and Watersheds Unit

The Lake Ontario Management Unit (LOMU) continues to monitor both Lake Ontario and St. Lawrence River (SLR) for aquatic invading species (AIS) and encourages both commercial fishers and members of the public to report any AIS. In 2018, environmental DNA (eDNA) was completed to monitor the area for the invasive species Tench (*Tinca tinca*) after reports of captures by commercial fishermen in both Lake Saint Francis (LSF) and Bay of Quinte (BOQ). Early detection of AIS presence in an ecosystem makes it possible to implement management actions to prevent or reduce their chances of establishment and spread into other environments.

Background

Tench are a member of the family Cyprinidae (carps and minnows) and are native to Europe and Western Asia although they have a history of introductions elsewhere. They are dark olive with a white to bronze belly and reddish-orange eyes. Their fins are dark and rounded with no bony spines and the scales are small and embedded in thick skin. The mouth is narrow and there is a small barbel at each corner (Fig. 10.3.1). Tench preferred habitat in stagnant waters with abundant vegetation and muddy substrate in ponds, lakes and slow-moving areas of rivers. They are also highly tolerant to low levels of oxygen in water. They are bottom feeders and are known to increase the turbidity of water as they stir up the mud to feed on insect larvae, crustaceans, mollusks, worms and plant debris. Potential concerns about invading Tench in the Great Lakes are that they can compete with other near-shore fish species for food, they may transmit several parasites and diseases to other fish and wildlife, and by consuming large quantities of aquatic snails which feed on algae, Tench may contribute to nuisance algal blooms.

Range

In Canada, Tench is established in the Columbia watershed in British Columbia and the Richelieu River in Quebec. To date, a wild population of Tench is not known to occur in Ontario waters however they have become established in Quebec waters of the SLR and in Lake Champlain. The original introduction of Tench in Quebec is attributed to an illegal aquaculture operation in the mid-1980s, from which the fish escaped.

In recent years, Tench have been captured in Ontario waters of the SLR by commercial fishers. Tench have been captured in Ontario waters of the LSF at Creg Quay in 2016 and 2017 (Table 10.3.1). Another five Tench were caught nearby in LSF in 2018. On September 27, 2018, the LOMU received a live Tench that was caught in Bay of Quinte near Belleville by a commercial fisher. That was the first observation of this species in the Great Lakes. Biological information collected on Tench caught in LSF and BOQ indicate that all fish are likely to be mature but

FIG. 10.3.1. Photograph of a live Tench caught in Lake Saint Francis in September 2018. Photograph provided by Tony David, Saint Regis Mohawk Tribe.

TABLE 10.3.1. Biological attributes of Tench captured by commercial fishers in 2016-2018.

Date of Capture	Location	Total Length (mm)	Round Weight (g)	Sex
September 2016	Lake Saint Francis	395	1111	Male
August 2017	Lake Saint Francis	434	1276	Male
September 2017	Lake Saint Francis	434	1324	Male
August 2018	Lake Saint Francis	410	897	Male
September 2018	Lake Saint Francis	427	1068	Male
September 2018	Lake Saint Francis	453	1197	Female
September 2018	Lake Saint Francis	394	996	Female
September 2018	Lake Saint Francis	401	912	Female
September 2018	Bay of Quinte	470	1392	Female

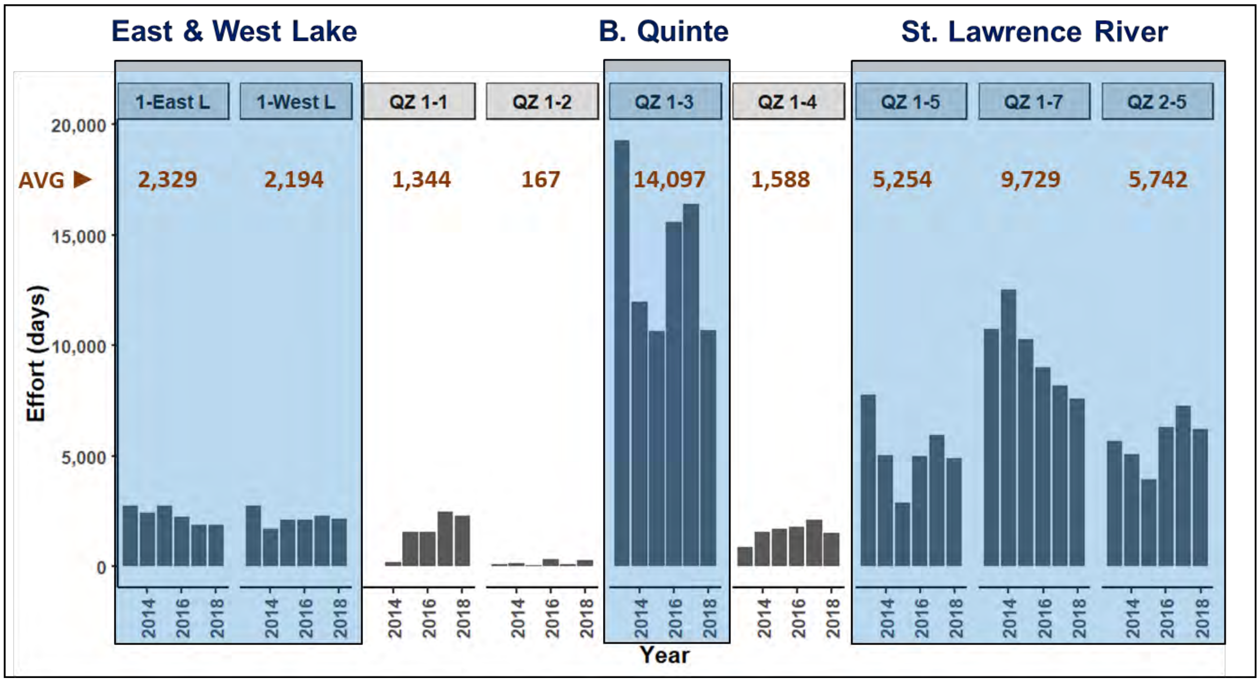


FIG. 10.3.2. Fishing effort of commercial fishers across quota zones showing the number of net days by year and their average.

there is no evidence of an established population in either location (Table 10.3.1).

Monitoring

Surveillance for Tench continues through LOMU's assessment programs, the local commercial fishery and local partners such as the SLR Institute of Environmental Studies and the Akwesasne First Nation. In addition, local anglers and bait fishers have been notified.

Community Index Gillnetting

In 2018, LOMU community index gillnetting in the LSF area was conducted with a total of 36 gill net sets and no Tench were caught. Assessment netting conducted by the LOMU field programs in several embayments across Lake Ontario also yielded no Tench.

Commercial fishing

The fishing effort commercial fishers have across quota zones is an important means for surveillance of invasive species. There were 15,298 entrapment gear net sets during 2018 in eastern Lake Ontario and the upper SLR (Fig. 10.3.2) and thus far, the only Tench that have been caught were from commercial fishers.

Environmental DNA (eDNA)

The MNRF conducts targeted surveillance for invasive species using a method known as eDNA. Environmental DNA is DNA that is released from an organism into the environment. This method examines water samples for DNA that has been shed by fish in search for genetic markers unique to that species. Once water samples in areas of interest are collected, targeted testing for a species of interest attempts to amplify DNA from that species to see if it's present in the water samples. Environmental DNA markers have been developed for Tench and their potential to detect the presence of the species in local waters has been tested.

In May 2018, LOMU collected eDNA samples at four locations in the SLR: outside Creg Quay where the Tench were captured, inside Creg Quay, upstream of Moses Saunders Dam and downstream of the Beauharnois Dam in Lac St. Louis. Sampling for eDNA occurred again on July 25, 2018 in the river at the same locations plus three additional locations: Summerstown, Glen Walter and the Cornwall marina. No Tench eDNA was detected in these samples.

After receiving a live Tench from a commercial fisher in The Bay of Quinte on September 27, 2018, eDNA samples were collected at two sites in the BOQ the day the Tench was caught. Samples were collected near Belleville at the location of the net that captured the Tench (approximately 4 hours after capture) and at Trenton. The live Tench was held in a tank at LOMU for a 24-hour period and three water samples were collected for eDNA from the holding tank. There was no detection of eDNA in Trenton however there were positive detections for Tench in both the holding tank and Belleville at the site of capture. Positive detection means DNA from the species was present at that location at the time the sample was collected. On October 3, 2018 LOMU staff collected six eDNA water samples for eDNA analysis from five sites in the Bay of Quinte: Belleville (same site that tested positive on September 27), Massassauga Point, Muscote Bay, Sucker Creek and Napanee River (Fig. 10.5.3). No Tench eDNA was detected in these samples.

Management Actions

Several management actions have been implemented by LOMU to inform stakeholders and prevent the spread of Tench in Lake Ontario. The ministry is currently performing a Risk Assessment to determine the threat of the species. Information sheets and signs have been prepared to provide Tench identification characteristics to commercial bait harvesters and anglers to reduce the risk of dispersal through baitfish buckets. Consultation has occurred with partners including the Great Lakes Fishery Commission, Fisheries and Oceans Canada (DFO) as well as the Mohawk Council of Akwesasne and the Mohawk of the Bay of Quinte. Implementing and maintaining monitoring programs as well as the involvement of various collaborators are essential to maximize the possibilities of detecting a species when it first appears. The ministry will continue to advise the public about Tench and encourage the public to report sightings of invasive species to the provincial Invading Species Hotline (1-800-563-7711 or invadingspecies.com).

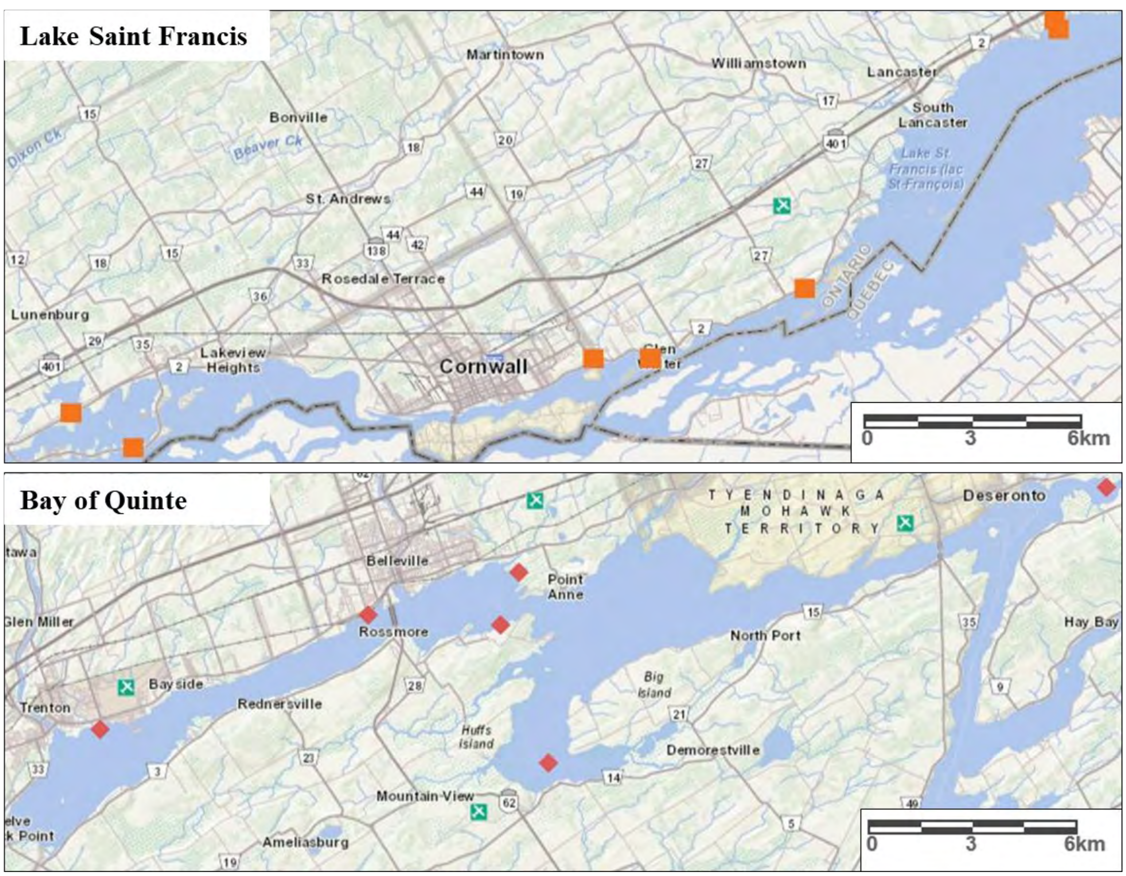


FIG. 10.3.3. Location of eDNA sampling for Tench in Lake Saint Francis and Bay of Quinte in 2018

11. Environmental Indicators

11.1 Water Temperature

J. P. Holden and J. A. Hoyle, Lake Ontario Management Unit

Winter Severity Index

Winter severity is often correlated with year-class strength in temperate fish species. A long-term (1944-2018) winter severity index is presented in Fig. 11.1.1. The winter of 2017 / 2018 was more severe than the long-term average as were seven of the last 20 years.

Mid-summer Water Temperature

Summer water temperatures can impact fish distribution and influence growth and survival of young of the year fish.

Bay of Quinte

A long-term (1944-2018) mid-summer water temperature index is presented in Fig. 11.1.2. Water temperature in the summer of 2018 was the warmest in the time series. Fifteen of the last 20 years were warmer than the long-term average.

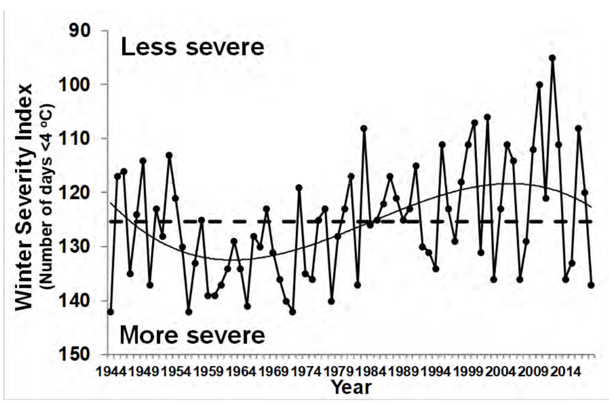


FIG. 11.1.1. Winter severity index, 1944-2018. Winter severity is measured as the number of days in December through April with a mean water temperature less than 4°C. By way of example, the 2018 data point includes the mean daily surface water temperature from Dec 1, 2017 to April 30, 2018. The long-term average index is depicted with a dashed line, and a third order polynomial fit to the data is shown as a thin solid line. Mean daily water temperature data was obtained from the Belleville (upper Bay of Quinte) Water Treatment Facility. The temperature data come from water drawn from the bottom at a depth of approximately 3.2 m. Water temperatures are homothermous in this section of the Bay.

Lake Ontario

Main lake surface water temperatures have been collected by the National Oceanic and Atmospheric Administration's National Data Buoy Center (www.ndbc.noaa.gov) at Station 45012 (East Lake Ontario – 20 nautical miles north of Rochester, NY, 43.621 N 77.406 W). Mean summer water temperature in 2018 was the third warmest value for the time series (2002 to 2018; Fig. 11.1.3).

Coldwater Habitat

Native coldwater species such as Lake Trout, Lake Whitefish and Cisco depend on access to suitable temperatures. Temperature profiles are collected at each Fish Community Index Gill Net and Trawl site (Section 1.1 and 1.2). Gill net site EB06 is an offshore site in the Kingston Basin (for a map, see Fig. 1.1.1) that can provide a representative index of available thermal habitat in summer months within the Kingston Basin through time. Profiles collected in July and August at EB06 (Fig. 11.1.4) show the seasonal warming (warmer water deeper) of the

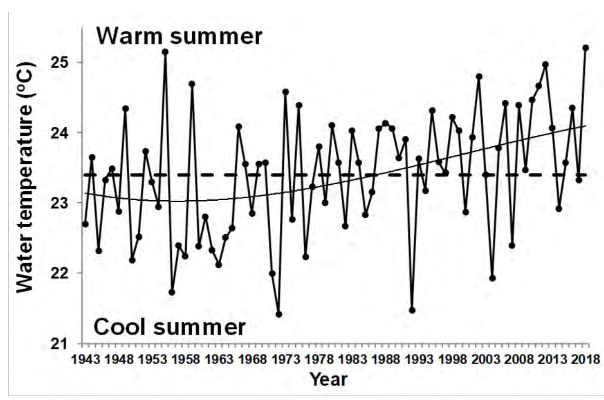


FIG. 11.1.2. Mean mid-summer water temperature (July and August; mean of 62 days) at the Belleville Water Treatment Facility, 1943-2018. The long-term average index is depicted with a dashed line, and a third order polynomial fit to the data is shown as a thin solid line. Mean daily water temperature data was obtained from the Belleville (upper Bay of Quinte) Water Treatment Facility. The temperature data come from water drawn from the bottom at a depth of approximately 3.2 m. Water temperatures are homothermous in this section of the bay.

Kingston Basin but do not capture the daily variability influenced by thermal mixing due to wind events. The water depth at which water temperature is below 15°C provides an index of the amount of coldwater habitat available between years which may influence catches of coldwater species such as Lake Trout and Lake Whitefish. A shallower depth of 15°C would indicate more coldwater habitat available (Fig. 11.1.5).

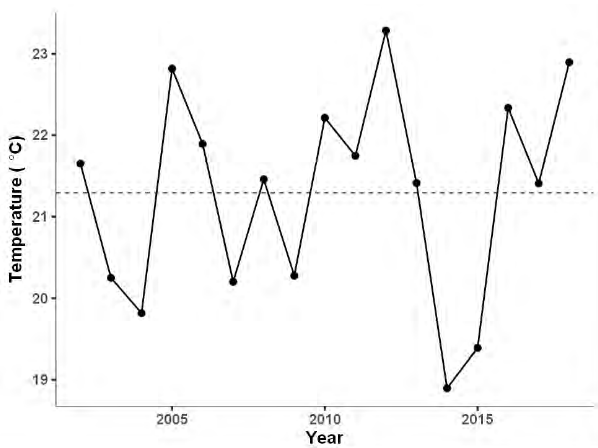


FIG. 11.1.3. Mean annual water temperatures in July and August collected at the National Oceanic and Atmospheric Administration's Station 45012 (East Lake Ontario – 20 nautical miles north of Rochester, NY). Data provided by National Data Buoy Center, NOAA (http://www.ndbc.noaa.gov/).

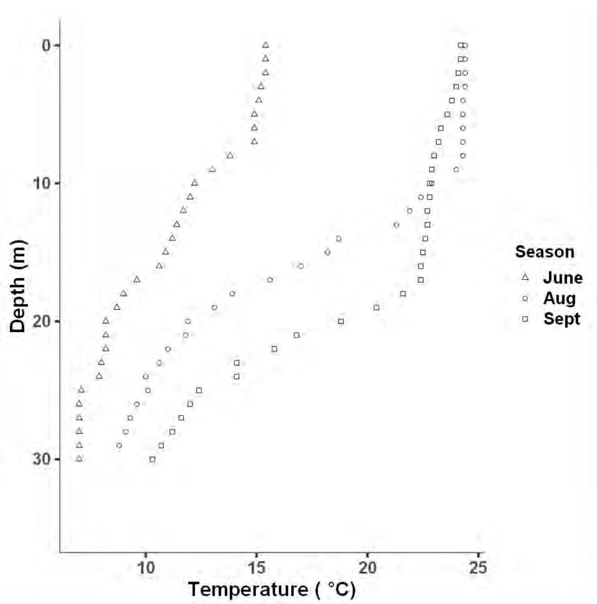


FIG. 11.1.4. Temperature profiles collected in July and August 2018 at Fish Community Index Gill Net (Section 1.2) site EB06.

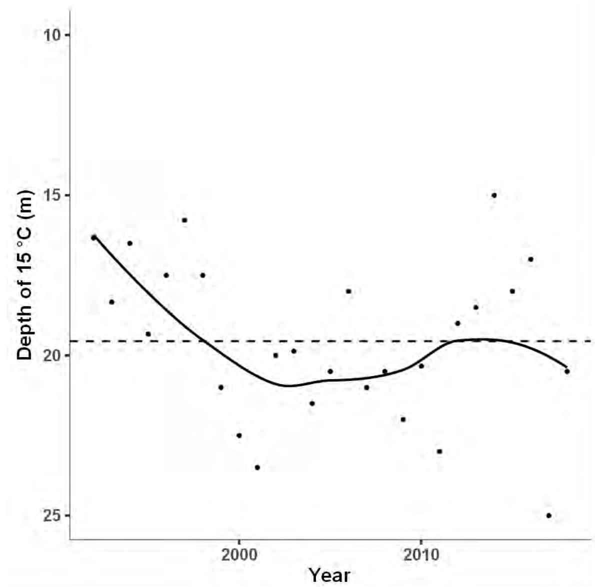


FIG. 11.1.5. Index of coldwater habitat in the Kingston Basin determined by July and August temperature profiles collected at Fish Community Index Gill Net (Section 1.1) site EB06. The solid line is the trend through time (loess fit) and the dotted line is the average depth of 15°C throughout the time-series (1992-2018).

11.2 Wind

M. J. Yuille, Lake Ontario Management Unit

National Oceanic and Atmospheric Administration (NOAA) records multiple weather variables using a variety of weather buoys deployed throughout Lake Ontario. Buoy data are available through the National Data Buoy Center webpage hosted by NOAA (http://www.ndbc.noaa.gov/). The Rochester weather buoy (Station ID# 45012; located 37 km offshore, north-northeast of Rochester) records several environmental variables, including wind direction and velocity ($m \cdot s^{-1}$). Wind direction and velocity can affect both the Lake Ontario ecosystem (e.g., thermal mixing, fish distribution) and the recreational fishery (e.g., total angler effort and the distribution of effort on Lake Ontario).

Two indices were developed to provide a wind index on Lake Ontario from 2002 – 2018 (Fig. 11.2.1). Small Craft Wind Warnings are issued for Lake Ontario by Environment Canada when wind velocities measure 20 – 33 knots (http://weather.gc.ca/marine/). The Small Craft Index represents the total number of hours from July 1st to August 31st each year, where the wind velocity was greater than or equal to 20 knots. This index shows that since 2007, the years 2010, 2011, 2014 and 2017 had higher than average small craft warnings and 2018 had the lowest number of warnings within July and August for the time series (Fig. 11.2.1a). A second index, the East Wind Index, was calculated to determine the total number of hours between July 1st and August 31st, each year, that an eastern wind predominated (Fig. 11.2.1b). This index shows an increase from 2017 to 2018, where the number of east wind hours was above the long-term average (Fig. 11.2.1b).

Lastly, wind direction and velocity have been summarized for the months of July and August from 2016 – 2018 (Fig. 11.2.2). The shade of grey corresponds to the speed of the wind (ms-1), where darker shades represent higher speeds, the location of the bar illustrates the direction the of the wind and the length of the bar represents the proportion of time within that year/month combination that the wind was blowing at that speed and direction. These analyses show the seasonal and annual variability in wind patterns on Lake Ontario. While, southwestern winds generally predominate through July and August (Fig. 11.2.2), the variability that exists may impact the Lake Ontario ecosystem as well as the recreational fishery.

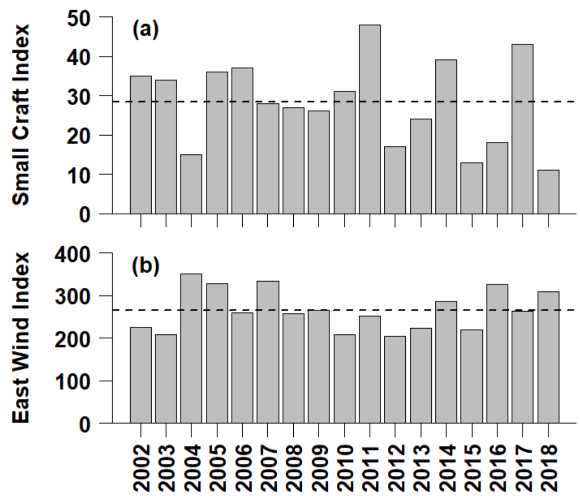


FIG. 11.2.1. Lake Ontario wind as characterized by the (a) Small Craft Index and (b) East Wind Index. The Small Craft Index represents the total number of hours from July 1st to August 31st each year (2002 – 2018), where the wind velocity was ≥ 20 knots. The East Wind Index represents the number of hours from July 1st to August 31st each year (2002 – 2018) that an eastern wind predominated. Data provided by National Data Buoy Center, NOAA (http://www.ndbc.noaa.gov/).

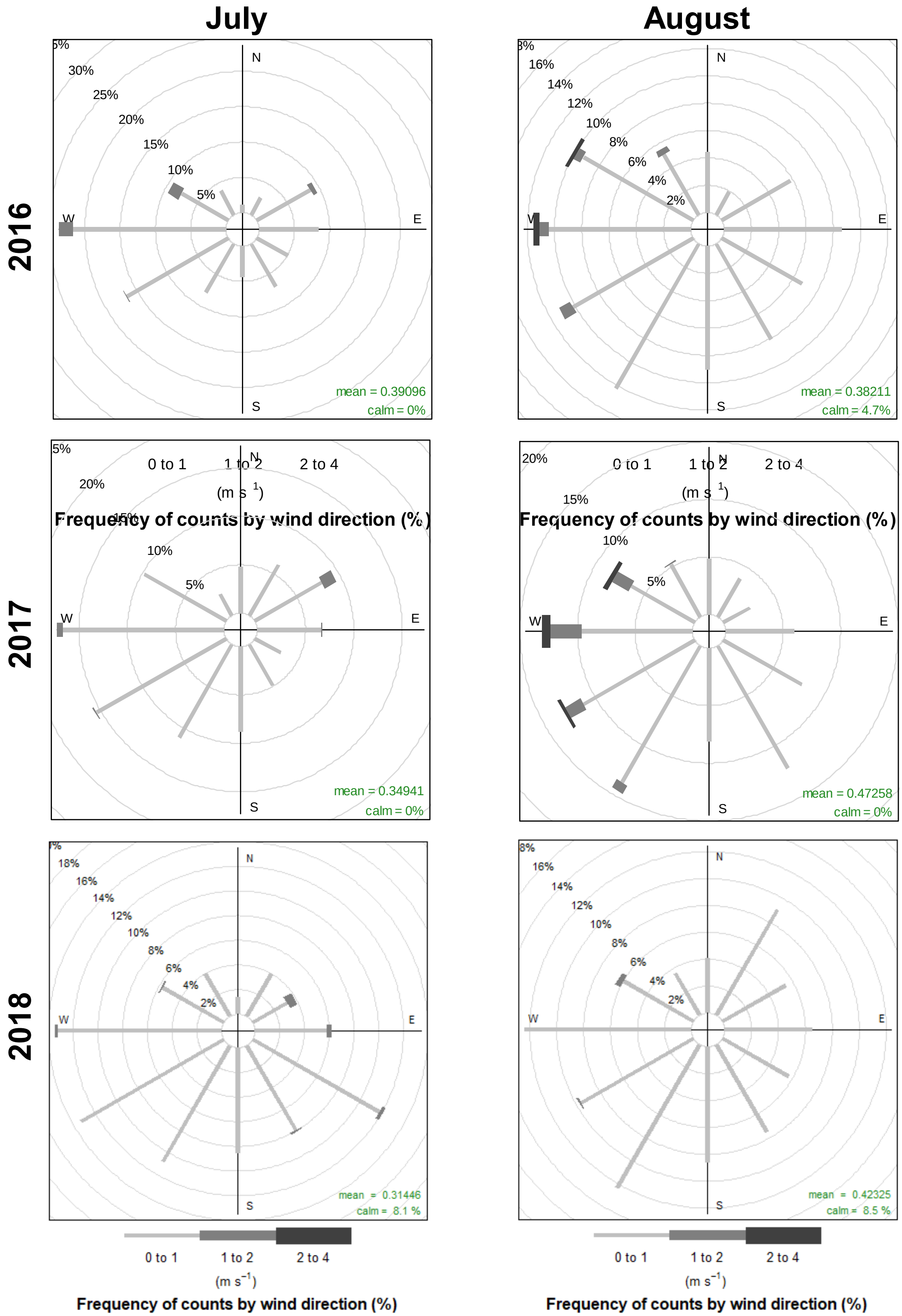


FIG. 11.2.2. Wind direction and velocity represented as a proportional frequency of occurrence for July and August in 2016 – 2018. Wind velocities of 0 – 1 knots are light grey, 1 – 2 knots are medium grey and > 2 knots are dark grey. Data provided by National Data Buoy Center, NOAA (http://www.ndbc.noaa.gov/).

11.3 Water Clarity

J. P. Holden, Lake Ontario Management Unit

Summer Water Transparency

Water clarity is measured using a Secchi disk at each Fish Community Index Gill Netting site (Section 1.1). The maximum depth the Secchi disk can be observed is an index of water clarity. Mean annual water clarity varies between the Bay of Quinte, Kingston Basin and the Eastern Portion of Lake Ontario (measured at Rocky Point gill net sites). Bay of Quinte Secchi depths are generally lower (less clear) than main lake sites and have been increasing (i.e. reduced clarity) through the time series. Similarly, Rocky Point is marginally clearer than the Kingston Basin but neither show a trend through time series (1993 to present). Year to year variation in Kingston Basin and Rocky point are highly correlated throughout the time series.

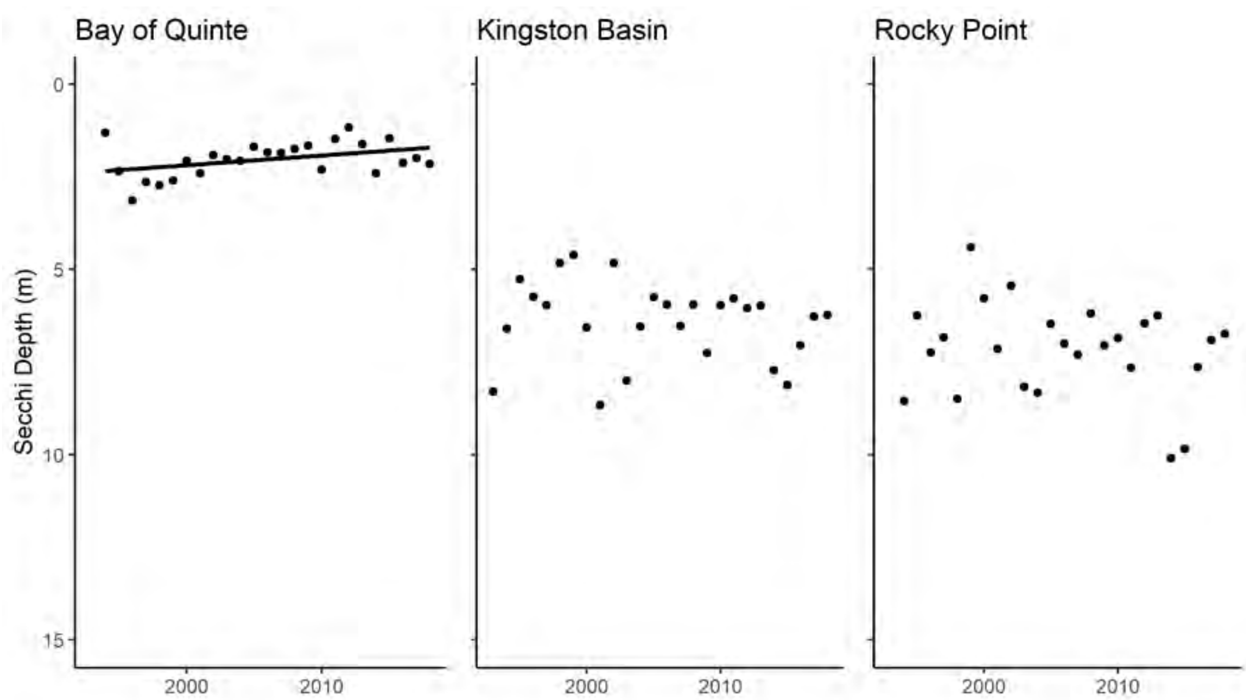


FIG. 11.3.1. Mean annual water clarity determined by Secchi disk readings collected at Fish Community Index Gill Net sites in June, July and August. Secchi Depth in the Bay of Quinte exhibits an increasing trend (i.e. reduced clarity) through the time series (1993-2018).

11.4 Tributary Water Flow

E. Brown, Lake Ontario Management Unit

Tributary water flow regimes can impact fish species that use Lake Ontario's tributaries for spawning and rearing grounds. For example, migratory salmonid species such as Rainbow Trout and Chinook Salmon rely on cold water tributaries during the spring and fall in areas where natural reproduction occurs. Native cool water species such as Walleye, Northern Pike, and Lake Sturgeon may also use tributary areas for spawning during the spring. Though flow regimes can be described using several metrics, in this report, annual discharge data ($m^3 \cdot s^{-1}$) and central flow timing (i.e. date at which half the annual discharge has been exceeded) are used. Average annual discharge is used to describe large-scale comparison in flow among years, whereas central flow timing is used to indicate whether the annual discharge occurred early or late in the season relative to the long-term average. For the purpose of this report, 2018 central flow Julian day is compared to a five year average (2013-2017).

Water Surveys of Canada (WSC) collects hydrometric data from gauges across Canada, which are available through the Environment Canada webpage (http://wateroffice.ec.gc.ca/index_e.html). Discharge data from three stations (listed and described Table 11.4.1) were retrieved in February 2019 and summarised to characterise tributary water flow regimes. At the time of this report, 2018 daily discharge data are considered provisional by the Environment and Climate Change Canada and subject to change.

The Credit River drains into the western end of Lake Ontario and provides fishing opportunity for migratory salmonids within the river and lake basin (see Section 1.5) . In 2018, the average annual discharge at the Credit River (Station ID: 02HB029) was higher than the long-term average (Fig. 11.4.1). The central flow Julian day date was 125, indicating that flows occurred earlier relative to the 5-year average (133).

The Ganaraska River receives annual runs of naturalized Chinook Salmon and Rainbow Trout and both of these species reproduce naturally within this river system (see Section 1.4). In 2018, the average annual discharge at the Ganaraska River (Station ID: 02HD012) was above the long-term average (Fig. 11.4.2). The central flow Julian day date in 2018 was the same as the 5-year average (135).

The Salmon River drains into the Bay of Quinte near Shannonville, Ontario. The lower reaches of this system provide spawning and rearing habitat for warm and coolwater species that inhabit the Bay of Quinte and Lake Ontario (e.g. Walleye). In 2018, the average annual discharge at the Salmon River (Station ID: 02HM003) was above the long-term average (Fig. 11.4.3). The central flow Julian day date was 109, indicating that flows occurred earlier relative to the 5-year average (113).

TABLE 11.4.1. Information of three Lake Ontario tributaries used in the stream flow analysis including river name, station ID, latitude and longitudes (Degrees Decimal Minutes), gross drainage area (km^2), and the Daily Discharge time series for each tributary.

River	Station ID	Latitude	Longitude	Gross Drainage Area (km^2)	Daily Discharge Time Series
Credit	02HB029	44° 34.933 N	79° 42.517 W	774.24	2005-2018
Ganaraska	02HD012	43° 59.450 N	78° 16.683 W	241.87	1976-2018
Salmon	02HM003	44° 12.433 N	77° 12.550 W	906.73	1958-2018

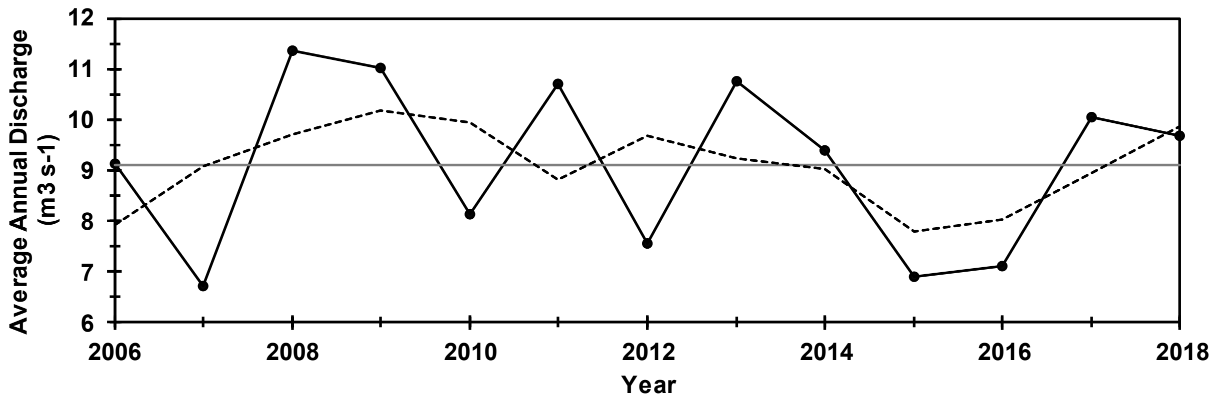


FIG. 11.4.1. Average annual discharge ($m^3 \cdot s^{-1}$) for the Credit River, Ontario (Station ID: 02HB029) from 2006 to 2018. The horizontal line is the average discharge over this time series and the dotted line represents the 3-year running mean. In 2018, the average annual discharge was 9.68 $m^3 \cdot s^{-1}$.

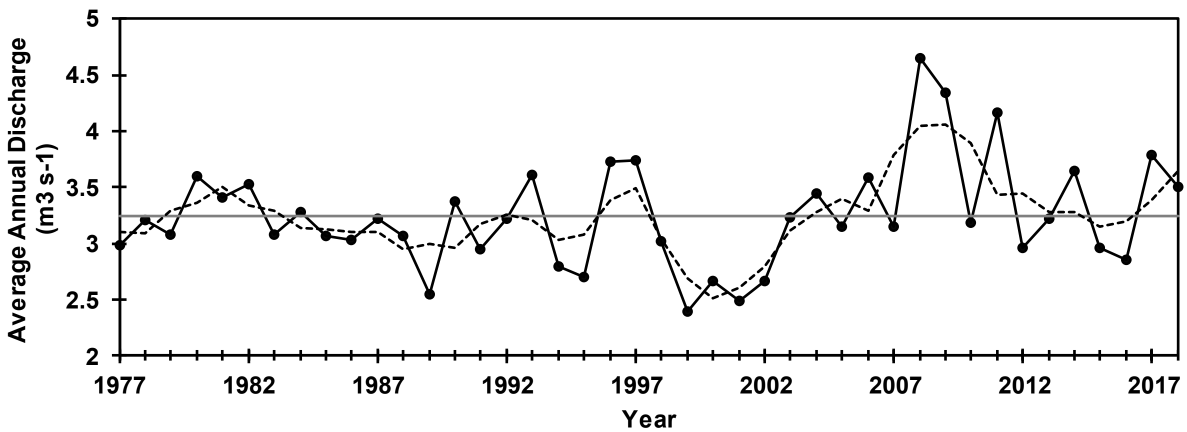


FIG. 11.4.2. Average annual discharge ($m^3 \cdot s^{-1}$) for the Ganaraska River, Ontario (Station ID: 02HD012) from 1977 to 2018. The horizontal line is the average discharge over this time series and the dotted line represents the 3-year running mean. In 2018, the average annual discharge was 3.5 $m^3 \cdot s^{-1}$.

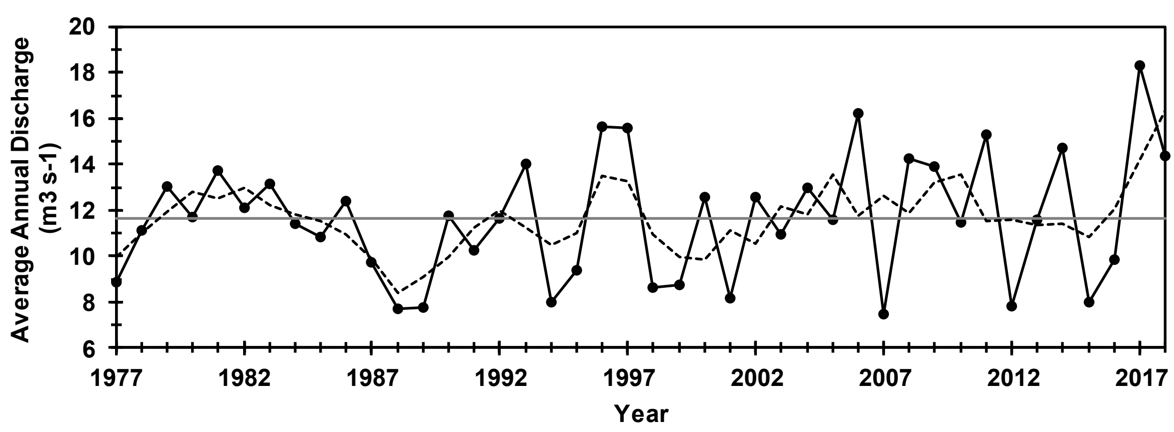


FIG. 11.4.3. Average annual discharge ($m^3 \cdot s^{-1}$) for the Salmon River, Ontario (Station ID: 02HM003) from 1977 to 2018. The horizontal line is the average discharge over this time series and the dotted line represents the 3-year running mean. In 2018, the average annual discharge was 14.35 $m^3 \cdot s^{-1}$.

12. Staff 2018

Glenora Fisheries Station, 41 Hatchery Lane, Picton, ON K0K 2T0
Tel: 613-476-3255 Fax: 613-476-7131

PROVINCIAL SERVICES DIVISION

Fish and Wildlife Service Branch
Lake Ontario Management Unit

Andy Todd	Lake Manager
Dawn Young	Administrative Assistant
Colin Lake	Lead Management Biologist
Jake LaRose	Lake Ontario COA Coordinator
Alastair Mathers	Assessment Supervisor
Marc Desjardins	Management Biologist
Jim Hoyle	Assessment Biologist
Jeremy Holden	Assessment Biologist
Mike Yuille	Assessment Biologist
Erin Brown	Assessment Biologist
Laura Johnson	Aquatic Ecologist Intern
Steve McNevin	Operations Supervisor
Sonya Kranzl	Operations Coordinator
Kelly Sarley	Support Services/Data Technician
Jon Chicoine	Vessel Master
Nina Jakobi	Great Lakes Technician RT3
Ben Maynard	Great Lakes Technician RT3
Steve Wingrove	Great Lakes Technician RT3
Alan McIntosh	Seasonal Boat Captain RT3
Tim Dale	Great Lakes Fisheries Technician RT3
Scott Brown	Great Lakes Fisheries Technician RT3
Brandon Perry	Great Lakes Fisheries Technician RT3
Tyson Scholz	Great Lakes Fisheries Technician RT2
Daniel Jang	Great Lakes Fisheries Technician RT2
Kassandra Robinson	Great Lakes Fisheries Technician RT2
Kevin Campbell	Great Lakes Fisheries Technician RT2
Ted Allan	Great Lakes Fisheries Technician RT2
Megan Murphy	Great Lakes Fisheries Technician RT2
Jake Gibson	Great Lakes Fisheries Technician RT2
Maeghan Brennan	Great Lakes Fisheries Technician RT2
Justin Werner	Great Lakes Fisheries Technician RT2
Cody Cribbett	Student Fisheries Technician
Taylor Huff	Student Fisheries Technician
Trevor Miller	Student Fisheries Technician
Rachel Agombar	Student Fisheries Technician
Connor Mitchinson	Student Fisheries Technician
Natalie Iezzi	Student Fisheries Technician
Jackson deBoef	Student Fisheries Technician

Enforcement Branch

Jeff Fabian	Conservation Officer
Julie Lawrence	Enforcement Manager, Peterborough

Science and Research Branch
Aquatic Research and Monitoring Section

Dr. Tim Johnson	Research Scientist
Brent Metcalfe	Research Biologist
Jeff Buckley	Project Biologist (Invasive Species)
Mary Hanley	Project Biologist (Food Webs)
Elizabeth Hatton	Project Biologist (Invasive Species)
Eloise Ashworth	Project Biologist (Invasive Species)
Adam Rupnik	Project Biologist (CSMI)
Brittany Payne	Student Research Technician
Maeghan Brennan	Student Research Technician

13. Operational Field and Lab Schedule, 2018

(SPA = Special Purpose Account; COA = Canada Ontario Agreement; CSMI = Cooperative Science and Monitoring Initiative; CRF = Consolidated Revenue Fund; TRCA = Toronto and Region Conservation Authority; OFAH = Ontario Federation of Anglers and Hunters; OPG = Ontario Power Generation; GLFC = Great Lakes Fishery Commission).

Field and Lab Projects	Dates	Species Assessed, Monitored or Stocked	Project Lead	Operational Lead	Funding Source
Public Outreach - Toronto Sportsmen's Show	Mar	Public Outreach/Education	Kranzl	Moore/Murphy	SPA
Atlantic Salmon Marking Program	Feb	Atlantic Salmon	Lake	Chicoine	SPA
Atlantic Salmon Classroom Hatchery Program	Jan-May	Atlantic Salmon	McNevin/ Dr.Johnson	Wingrove/ Dr.Johnson	OFAH
Ganaraska River Fish Counter Salmon and Trout Assessment	Mar-Nov	Migratory Trout & Salmon	Yuille	Maynard	COA/SPA/CRF
Ganaraska Fishway Rainbow Trout Assessment	Mar-Apr	Rainbow Trout	Yuille	Maynard	SPA
Walleye Egg Collection	Mar-Apr	Walleye	Kranzl	Wingrove	SPA
Foodweb Dynamics in Lake Ontario	Apr-Nov	Fish Community	Dr.Johnson	Metcalfe/ Hanley	COA/CSMI
Larval Fish Tows/Sampling	Apr-May	Larval Fish	Holden	Murphy	COA/CSMI
Migration and Spatial Ecology of BOQ / ELO Walleye (Acoustic Tagging)	Apr-Sept	Walleye	Hoyle/ E.Brown	Wingrove	SPA/Queen's
Chinook Salmon Tournament Sampling	Apr-Sept	Chinook Salmon	Yuille	Kranzl/Jang	SPA
Asian Grass Carp Emergency Response	Apr-Nov	Grass Carp	McNevin	Kranzl/McNevin	SPA
Aquatic Research Program	Apr-Nov	Food web & Invasive Species	Dr.Johnson	Metcalfe/ Hanley	SPA
Tench EDNA Surveillance	May-Aug	Tench	Mathers	L.Johnson/ Jakobi	SPA
Chinook Salmon Net Pens	Apr	Chinook Salmon	Lake	Jakobi	SPA
Lake Ontario Spring Prey Fish Trawling Survey	Apr	Alewife/Smelt	Holden	Chicoine/Dale	SPA
Fish Contaminant Sampling	Apr-Dec	Sport Fish	Kranzl	Jakobi	SPA
Lake St.Francis Open Water Angling Survey	May-Sept	Perch, Walleye and Bass	Yuille	Allen	SPA
St 81- Offshore Benthos and Zooplankton Survey	May-Oct	Lower Food Web	Dr.Johnson	Metcalfe	SPA
Spring American Eel Trap and Transfer	Apr-Jun	American Eel	Mathers	Gibson	OPG
Public Outreach - Belleville Cops for Kids Fishing Day	Jun	Public Outreach/Education	McNevin	Jakobi	SPA
Deepwater Cisco Acoustic Telemetry Research Program	Jun	Deepwater Cisco	Dr.Johnson	Chicoine/Dale	GLFC/COA
Trent River Lake Sturgeon Survey / Acoustic Tagging	May	Lake Sturgeon	Lake	Wingrove	COA
Queens University - Bay of Quinte/Eastern L.Ont Acoustic Receiver Program	Jun-Oct	Bass / Walleye	Dr.Tufts	Wingrove	SPA/Queen's
Eastern Lake Ontario and Bay of Quinte Community Index Netting	Jun-Nov	Fish Community	Hoyle/ E.Brown	Kranzl	SPA
Western Lake Ontario Community Index Netting	July	Fish Community	Hoyle/ E.Brown	Kranzl	SPA
Eastern Lake Ontario and Bay of Quinte Index Trawling	Jun-Sep	Fish Community	Hoyle/ E.Brown	Kranzl	SPA

Continued on next page

13. Operational Field and Lab Schedule, 2018 *(continued from previous page)*

(SPA = Special Purpose Account; COA = Canada Ontario Agreement; CSMI = Cooperative Science and Monitoring Initiative; CRF = Consolidated Revenue Fund; TRCA = Toronto and Region Conservation Authority; OFAH = Ontario Federation of Anglers and Hunters; OPG = Ontario Power Generation; GLFC = Great Lakes Fishery Commission).

Field and Lab Projects	Dates	Species Assessed, Monitored or Stocked	Project Lead	Operational Lead	Funding Source
Lake-wide Hydroacoustic Assessment of Prey fish	July	Prey Fish Community	Holden	Chicoine/ Wingrove	COA
Public Outreach - Hamiton Harbour Kids Fishing Day	Aug	Public Outreach/Education	Todd	Jakobi	SPA
Hamilton Harbour Nearshore Community Index Netting	Aug	Nearshore Fish Community	Holye/ E.Brown	Wingrove	COA/DFO
Point Petre Receiver Array	Aug	Cisco, Whitefish, Walleye, Bass, Eel	Dr. Johnson	Chicoine	COA/SPA
Credit River Fish Counter Salmon and Trout Assessment	Aug-Nov	Migratory Trout & Salmon	Yuille	Maynard	COA/SPA/CRF
Toronto Waterfront Nearshore Community Index Netting	Sept	Nearshore Fish Community	Holye/ E.Brown	Perry	COA/TRCA
Upper Bay Nearshore Community Index Netting	Sept	Nearshore Fish Community	Holye/ E.Brown	Moore	COA
Lake St. Francis Community Index Netting	Sept	Fish Community	Yuille	Scholz	COA
Ganaraska Chinook Salmon Assessment and Egg Collection	Sept	Chinook Salmon	Yuille	Maynard	SPA
Pelagic Midwater Trawling / Acoustic Transects	Sept	Cisco/Various Pelagic Speices	Holden	Chicoine/Dale	COA/CSMI
Fall American Eel Trap and Transfer	Sept-Oct	American Eel	Kranzl	S.Brown/ L.Johnson	OPG
Lake Ontario Fall Benthic Prey Fish Trawling Survey	Sept-Oct	Round Goby/Slimy and Deepwater Sculpin	Holden	Chicoine	COA
Credit River Chinook Salmon Assessment and Egg Collection	Oct	Chinook Salmon	Yuille	Wingrove	SPA
Commercial Catch Sampling	Oct-Nov	Lake Whitefish	Hoyle	Jakobi	SPA
BOQ Cisco Acoustic Tagging	Oct-Nov	Cisco	Holye/ E.Brown	Wingrove/ Moore	SPA / Queen's / Windsor
ELO Whitefish Acoustic Tagging	Oct-Nov	Whitefish	Holye/ E.Brown	Wingrove/ Moore	SPA / Queen's
Fall Bay of Quinte Bottom Trawling	Nov	Cisco / Whitefish / Fish Community	Holden	Scholz	COA/CSMI
Fall BOQ Broadscale Monitoring (Gillnets)	Nov	Fish Community	Holden	Perry	COA/CSMI
Age and Growth (Lab)	Year-Round	Multiple Species	Multiple	Kranzl	SPA
Deepwater Cisco Restoration Stocking	Nov	Deepwater Cisco	Lake	Chicoine	SPA
Deepwater Cisco Research Acoustic Telemetry Stocking	Nov	Deepwater Cisco	Dr.Johnson	Chicoine	COA/SPA

14. Primary Publications 2018

Primary Publications of Glenora Fisheries Station Staff[1] in 2018

Brooks, J.L., Midwood, J.D., Gutowsky, L.F.G, Boston, C., Doka, S., **Hoyle, J.A.** and Cooke, S.J. 2019. Spatial ecology of reintroduced walleye (Sander vitreus) in Hamilton Harbour of Lake Ontario. Journal of Great Lakes Research. 45 (1): https://doi.org/10.1016/j.jglr.2018.11.011.

Drouillard, K.G., Feary, D.A., Sun, X., O'Neil, J.A., Leadley, T., **Johnson, T.B**. 2018. Comparison of thermal tolerance and standard metabolic rate of two Great Lakes invasive fish species. J. Great Lakes Res. 44: 476-481.

Hatton, E.C., **Buckley, J.D.**, Fera, S., Henry, S., Hunt, L.M., Drake, D.A.R., and **Johnson, T.B.** 2018. Ecological temperature metrics for invasive fishes in Ontario and the Great Lakes Region. Ontario Ministry of Natural Resources and Forestry, Science and Research Branch, Peterborough, ON. Science and Research Information Report IR-15.27p. + append.

Hoyle, J.A., Boston, C.M., Chu, C., **Yuille, M.J.**, Portiss, R., Randall, R.G. 2018. Fish Community Indices of Ecosystem Health: How does Toronto Harbour Compare to other Lake Ontario Nearshore Areas? Aquatic Ecosystem Health & Management, 21:3, 306-317, DOI: 10.1080/14634988.2018.1502562.
Ives, J.T., McMeans, B., McCann, K., Fisk, A.T., Johnson, T.B., Bunnell, D.B., Frank, K.T., Muir, A.M. 2018. Food-web structure and ecosystem function in the Laurentian Great Lakes – toward a conceptual model. Freshwat. Biol. 64: 1-23.

Klinard, N.V., Halfyard, E.A., Fisk, A.T., Stewart, T.J. and **Johnson, T.B.** 2018. Effects of surgically implanted acoustic tags on laboratory body condition, growth, and survival in a small laterally compressed forage fish. Trans. Amer. Fish. Soc. 147: 749-757

Marin Jarrin, J.R., **Johnson, T.B.,** Ludsin, S.A., Reichert, J.M., and Pangle, K.A. 2018. Do models parameterized with observations from the system predict larval yellow perch (Perca flavescens) growth performance better in Lake Erie? Can. J. Fish. Aquat. Sci. 75: 82-94.

Mumby, J.A., **Johnson, T.B.,** Stewart, T.J., Halfyard, E.A., Weidel, B.C., Walsh, M.G., Lantry, J.R., and Fisk, A.T. 2018. Feeding ecology and niche overlap of Lake Ontario offshore forage fish assessed with stable isotopes. Can. J. Fish. Aquat. Sci. 75: 759-771 and 75: 1560-61. doi 10.1139/cjfas-2016-0150

Mumby, J.A., Larocque, S.M., **Johnson, T.B.,** Stewart, T.J., Fitzsimons, J.D., Weidel, B.C., Walsh, M.G., Lantry, J.R., **Yuille, M.J.,** Fisk. A.T. 2018. Diet and trophic niche space and overlap of Lake Ontario salmonid species using stable isotopes and stomach contents. J. Great Lakes Res. 44: 1383-1392 doi.org/10.1016/j.jglr.2018.08.009

[1] Names of staff of the Glenora Fisheries Station are indicated in bold font.

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